GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

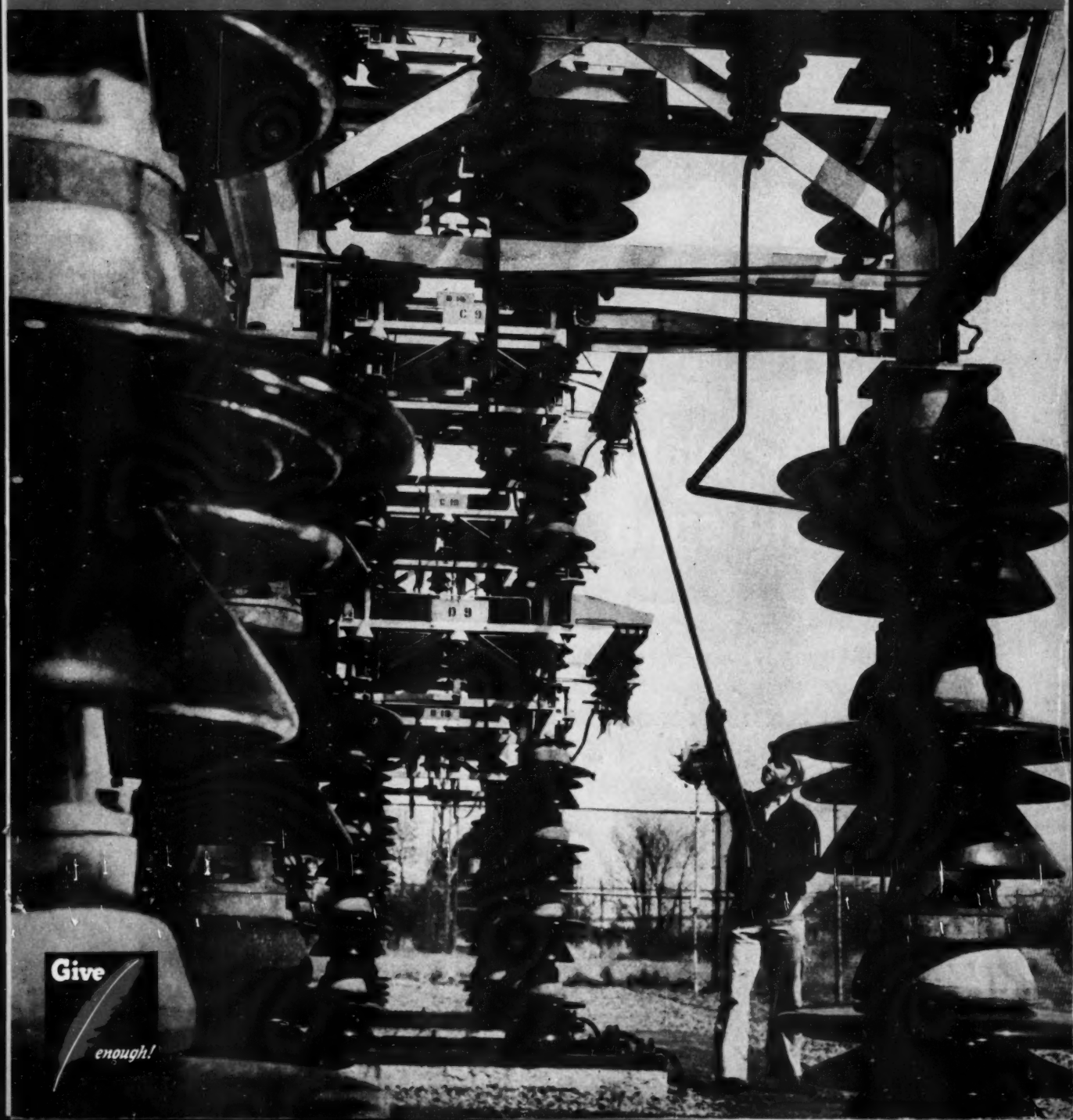
Power

A McGRAW-HILL PUBLICATION October 1953·50¢

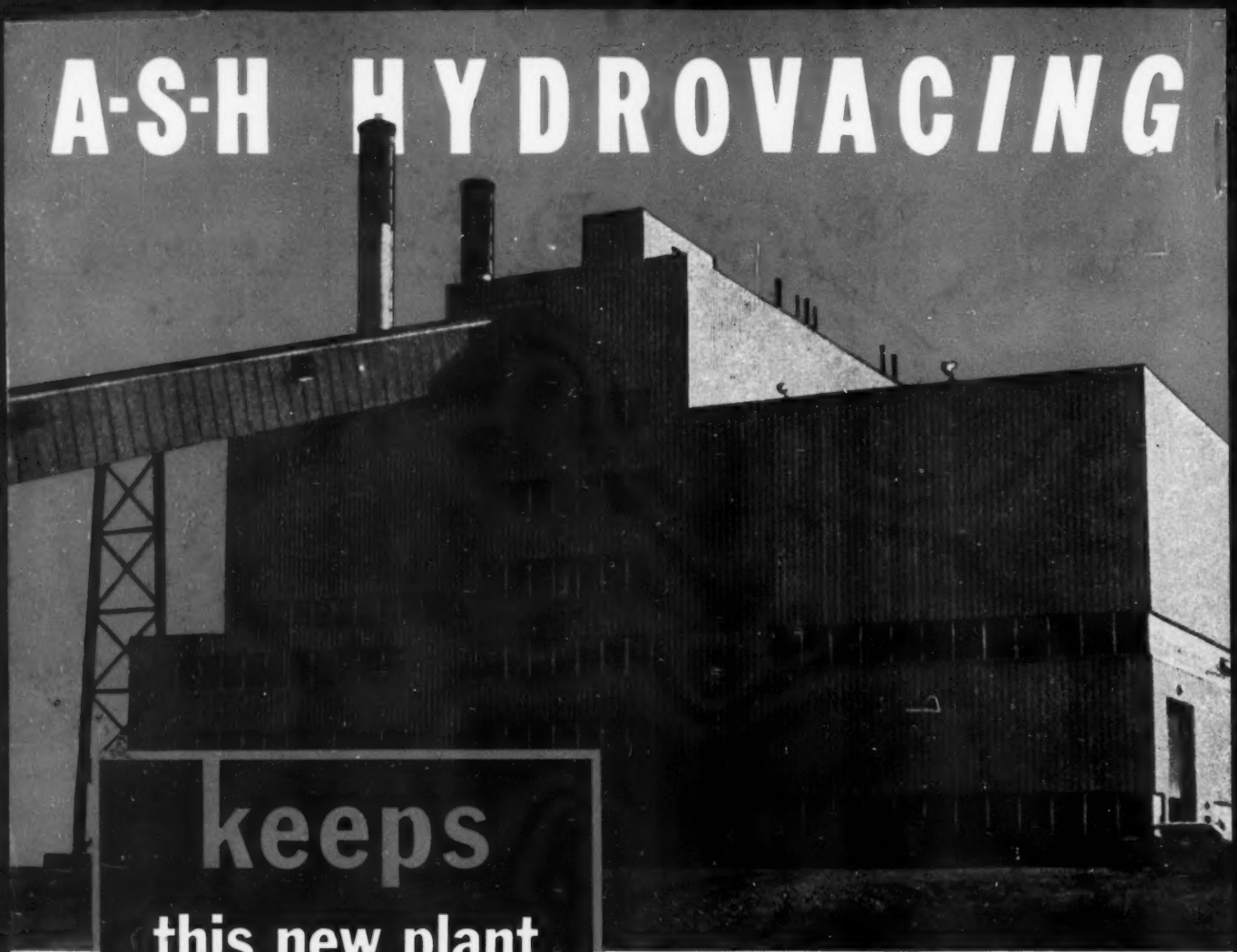
in this issue

TODAY'S ELECTRICAL PRACTICE

a 52-p report



A-S-H HYDROVACING



keeps this new plant spic and span

The William J. Neal Station at Velva, N.D.

Good housekeeping is a watchword at Central Power Electric Cooperative's plant in North Dakota. Located near the Souris River, this new lignite-fired plant is a major factor in developing this rich area.

The installation includes two boilers, each with a steam capacity of 230,000 lb. per hr., a design pressure of 975 psi, and a total temperature of 905°F.

The lignite residue is handled by a pneumatic Hydrovac System equipped with manually-operated valves, and is discharged through primary and secondary collectors into a storage silo.

Power-plant cleanliness with economy is a result of A-S-H pioneering. Ask our engineers for suggestions toward solving your materials handling problem. Write or wire.

THE ALLEN-SHERMAN-HOFF CO.
Dept. A—259 E. Lancaster Ave., Wynnewood, Pa.
Offices and Representatives in Principal Cities

HYDROJET *(hydraulic)* **HYDROVAC** *(pneumatic)*

materials handling systems

TOTAL ENGINEERING

The reclaiming of coal from power plant's storage area is facilitated by Link-Belt belt conveyor system. Fed by Link-Belt apron conveyor, 30-in. wide belt conveyor discharges coal in crusher house.

It's your assurance of top efficiency with LINK-BELT belt conveyors

HERE'S how "total engineering" works for you when you use Link-Belt Belt Conveyors. First, Link-Belt conveyor engineers analyze your needs—then recommend the *right* components. In addition, Link-Belt can supply all related equipment — other types of conveyors, feeders, elevators, car dumpers and shakers. And Link-Belt will build your supporting structures and enclosures . . . install the job completely, if desired. Call the Link-Belt office near you for any engineering assistance you need.

LINK-BELT

BELT CONVEYOR EQUIPMENT 13,285-B

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales offices in Principal Cities.

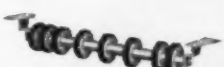
LINK-BELT builds a complete line of belt conveyor components

ALL TYPES OF ROLLER BEARING IDLERS

Return idler

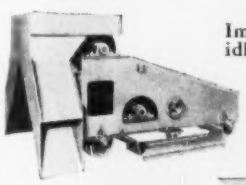
20° troughed idler

Belt-training idler



Rubber tread return idler

Impact-cushioning idler

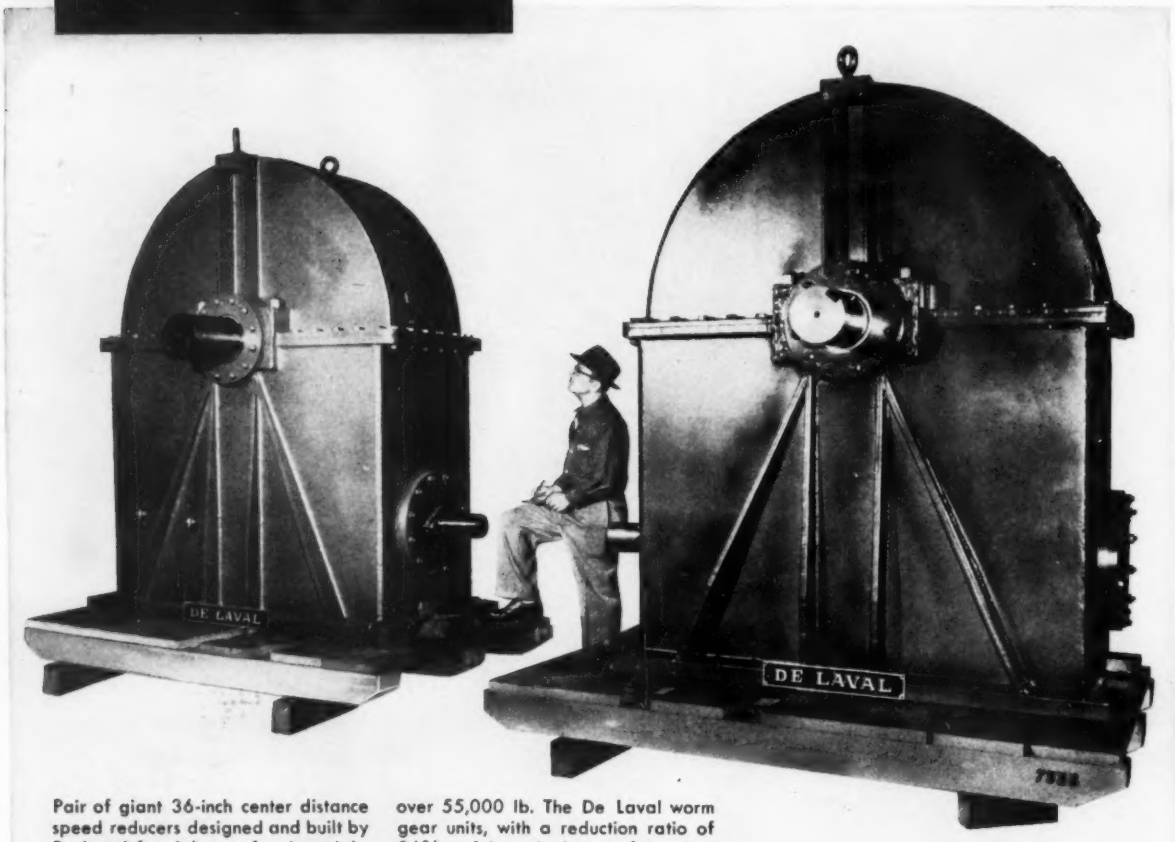


BELT AND MOTOR PROPELLED TRIPPERS

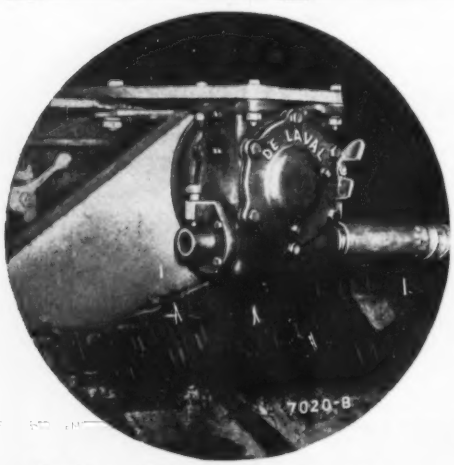
COMPLETE TERMINAL MACHINERY

DE LAVAL
SPEED REDUCERS

from dwarf to giant size



Pair of giant 36-inch center distance speed reducers designed and built by De Laval for slab transfers in a slabbing-blooming mill. These slab transfers are used to convey steel slabs up to 12 in. thick and 42 in. wide, weighing over 55,000 lb. The De Laval worm gear units, with a reduction ratio of 26⅔ to 1 in a single set of gearing, are each driven by a 200 hp, 410 rpm motor coupled directly to the input shafts of the slab transfers.



Here's one of the smaller De Laval worm gear speed reducers with a 3″ center distance being used for a new coal drilling machine.

De Laval heavy-duty worm gear speed reducers seldom require attention under the most rugged operating conditions. They make a quiet, close-couple compact drive. They permit high ratio reductions in a minimum of space and withstand severe shock loads without damage. De Laval builds all sizes from 3″ to 36″ center distances for transmission ratios of 3.1:1 to 100:1 in single reduction units and ratios of 50:1 to 8000:1 in double reduction units. Whether you need dwarf or giant worm gearing, consult De Laval for engineering assistance. *Send for De Laval Manuals G-WBV and G-WWH containing data on single and double reduction units.*

DE LAVAL *Speed Reducers*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey DL-310

Power

OCTOBER 1953 • VOLUME 97 NUMBER 10

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OCTOBER 1953 POWER Vol. 97—No. 10

POWER (with which are consolidated *Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer* and *Operating Engineer*) is published monthly with an additional Handbook statistical number in September, by McGraw-Hill Publishing Company, Inc. James H McGraw (1860-1948), Founder.

EXECUTIVE, EDITORIAL and ADVERTISING OFFICES: 330 W 42nd St, New York 36, N. Y. Curtis W McGraw, President; Willard Chevalier, Executive Vice-President; Joseph A Gerardi, Vice-President and Treasurer; John J Cooke, Secretary; Paul Montgomery, Senior Vice-President, Publications Division; Ralph B Smith, Vice-President and Editorial Director; Nelson Bond, Vice-President and Director of Advertising; J E Blackburn, Vice-President and Director of Circulation.

SUBSCRIPTIONS: Address correspondence to POWER, Subscription Service, 330 W 42nd St, New York 36, N. Y. Allow one month for change of address. Subscriptions are solicited only from executives, engineers and supervisory personnel engaged in design, operation and maintenance of power, light, heat and other plant services in utilities, construction firms, industrial and service plants. Position and company connection must be indicated on subscription orders.

Single copies: U. S. and possessions, Canada 50¢ (except mid-September Handbook $1.00); all other countries $1.50. Subscription rates—U.S. and U.S. possessions: $4.00 for one year, $6.00 for two years, $8.00 for three years. Canada: $6.00 for one year, $10.00 for two years, $12.00 for three years. All other countries: $15.00 for one year, $25.00 for two years, $30.00 for three years. Re-entered as second-class matter July 7, 1953 at the post office at New York, N. Y. under Act of March 3, 1879. Printed in U. S. A. Copyright 1953 by McGraw-Hill Publishing Company, Inc. All rights reserved.

POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index.

ELECTRICAL ADVANCES that make today's practices better and more economical (see report beginning on p 73) stem from many and varied sources. Some have their birth in laboratories—both basic-science labs and big engineering units like General Electric's Switchgear Development Laboratory at Philadelphia. That's where our cover photo was taken, at a capacitor bank just outside the main buildings.

Other advances are hatched in the fertile minds of design engineers, and still others grow out of operating experiences and problems. Regardless of source, the results show up in improved materials, better designs of familiar equipment, completely new electrical devices. And, equally important, in more solid knowledge on which to base the engineering decisions involved in selection and installation.

Next month . . .

■ As you might guess, feeding a boiler operating above the critical pressure presents pump problems. How these were solved by DeLaval engineers will be revealed in an exclusive November article. We've had itching fingers ever since the manuscript came in, but the big "special" on electrical practice kept it out of this issue.

■ You'll want to keep an eye out for the upcoming 8-page photo record of a turbine overhaul. In pictures that do the job of thousands of words, you'll see exactly how a good job is done.

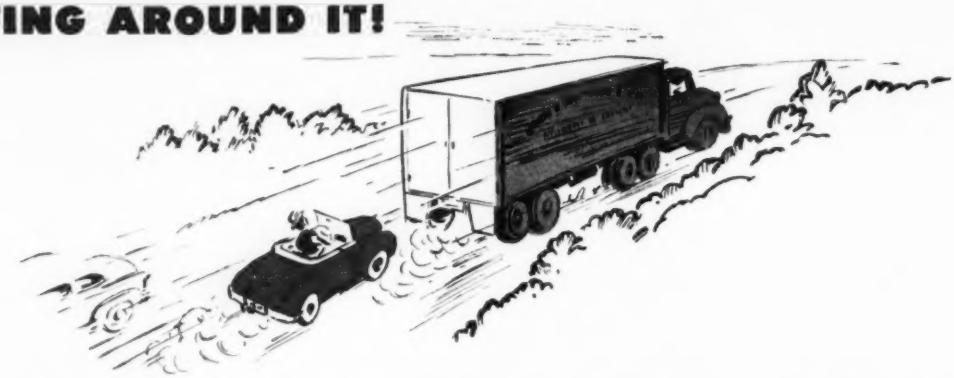
■ Dr B J Covner tells you how "human engineering" can show ways of learning which of several equipment designs best meets operators' needs and hence yields fewest errors, least fatigue.

■ Cleaning blast-furnace gas is fairly common practice. But at one big mill they go a step further and recover the solid products, for reuse in the process and to prevent stream pollution. Read how they do it in November.

. . . and future months

■ Next special report (December) will cover all phases of fuel handling and storage—for liquid and gas fuels as well as coal. Here's your chance to get up-to-date on an operation where mechanization makes big savings.

NO GETTING AROUND IT!

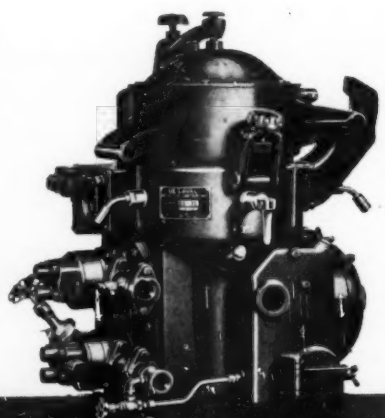


De Laval Turbine Oil Purifiers Prevent Contamination Trouble by Removing the Causes

De Laval Centrifugal Oil Purifiers remove both of the chief causes of lubricating oil deterioration—dirt and water. They are positive insurance that no trouble will occur that can be charged to impure oil.

A De Laval Oil Purifier does a thorough job. Every drop of water is promptly thrown out by centrifugal force and continuously discharged to waste. Dirt is likewise thrown out of the oil and stored outside of the zone where purification takes place.

An important advantage of the De Laval Oil Purifier is the fact that it has enough reserve capacity to take care of a sudden emergency such as a surge of water due to a leak.



THE DE LAVAL SEPARATOR COMPANY
Chicago POUGHKEEPSIE, N.Y. San Francisco

DE LAVAL

FOR MORE DEPENDABLE POWER PRODUCTION

Power

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...with Power readers...

65 YEARS OF 'POWER' . . .

I enclose check for $8.00, for which renew my subscription to POWER *for another three years. In passing, I am pretty sure that will make 65 years since I first subscribed in 1892.* —GEORGE R FOSDICK, SR *Winchester, N. H.*

With this recent letter in mind, our publisher, Shelton Fisher, routed his vacation trip through Winchester, in hopes of a pleasant chat with one of POWER's senior subscribers. His hopes were more than fulfilled—and he also heard an interesting story of POWER's part in Fosdick's career.

Now in charge of power operations of five units of New England Box Co, Fosdick began lifelong association with matters mechanical and electrical as motorman on an early street railway in Derby, Conn., in 1888. Twelve years later, B W Porter, one of the owners, left to go in the box business. He took young Fosdick as "engineer."

One probable reason for Porter's choice was that eight years earlier, in 1892, he saw that this motorman intended something more for himself. He had then become a thoughtful reader of a young technical publication called POWER. From that year, almost the entire education and engineering knowledge that George Fosdick has employed so well has come from POWER's pages. As he told Shelton Fisher, it has been his trade school, his college, his graduate school. And as evidenced by his letter, he hasn't stopped learning.—ED.

...lines and bylines

O'Connor records talk with Harry Segel and Frank Aime of Anaconda

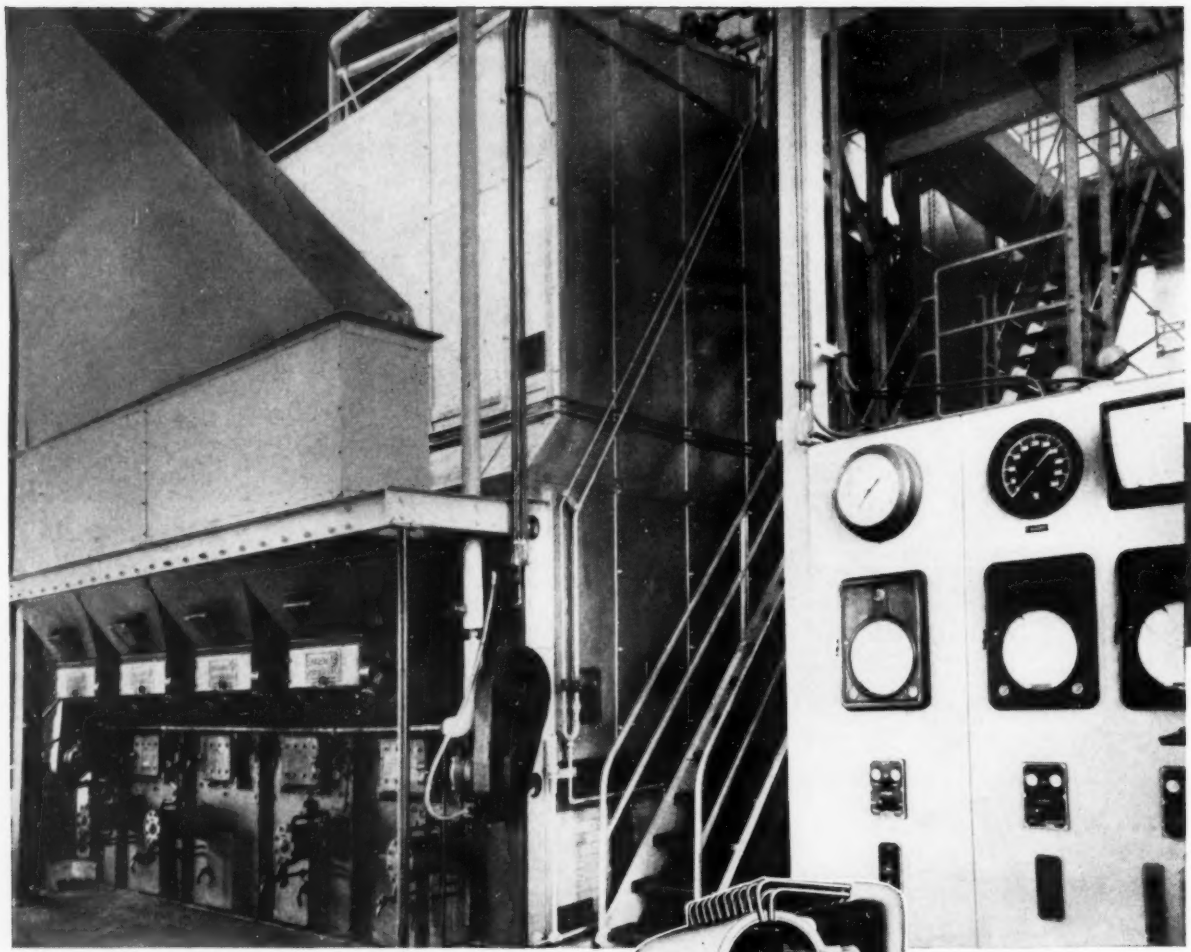
ON THE RECORD go some up-to-the-minute data on electrical conductors, as Associate Editor Jim O'Connor interviews top engineers of Anaconda Wire & Cable Co. Photo was taken last Feb 12, when Jim was in the midst of a 2-month swing around the country, gathering facts for the report on electrical practice that begins on p 73.

In that tour, he talked with more than 200 experts of some 40 companies in 11 states. And he did the whole king-size job *without writing a single note.* A carefully studied outline sent in advance guided the discussions and, at psychological points, Jim dictated into his recorder the gist of the talk on a given subject. As he worked his way cross-country, he sent back a steady stream of plastic disks for transcribing, found a mountain of typed notes waiting for him on his return to the POWER office.

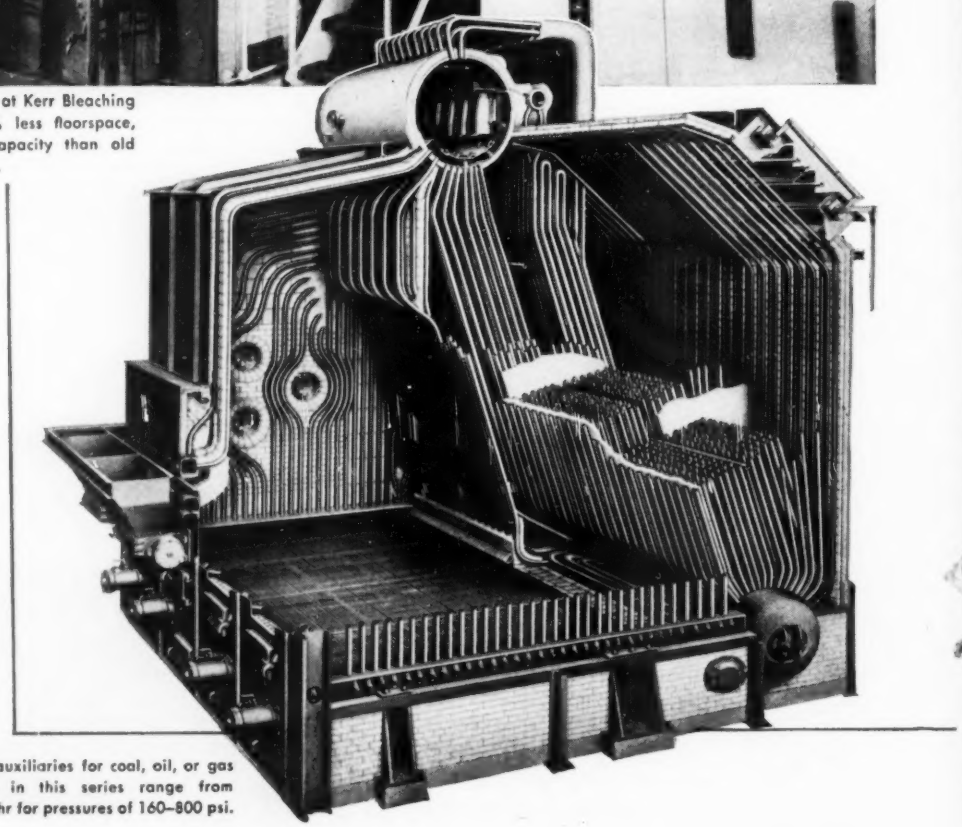
When he sat down to plot out the handling of this mass of data with Executive Editor Lou Rowley, it was clear to both that logical organization was the prime essential and that Ladislav Sutnar was the man to consult. It was his striking layouts and drawings that so many of you remarked on in our Sept 1952 special report on *Water.* In this electrical report, he displays another side of his genius, a flair for lucid visual organization of information.

Then began over 1000 editorial manhours of writing and rewriting. Finally on a September day when New York sweltered in temperatures close to 100 F, the final piece of copy was written, the last drawing checked. Then Lou and Jim "celebrated"—see photo, *below.*

Lou Rowley, Jim O'Connor "pause" as 52-p electrical report goes to bed



B&W Integral-Furnace Boiler, Type F J at Kerr Bleaching and Finishing Works, required 46% less floorspace, yet delivered 50% higher steam capacity than old installation of nine separate boilers.



Type F J unit and auxiliaries for coal, oil, or gas firing. Capacities in this series range from 30,000–70,000 lb/hr for pressures of 160–800 psi.

G-486

WHAT HAPPENED...

When 1 New B&W Integral-Furnace Boiler Replaced 9 Old Boilers...

. . . at

KERR BLEACHING *and* FINISHING WORKS

When this Concord, N. C. Company found their nine old boilers were not yielding adequate steam to maintain steady production, they commissioned A. G. Odell, Jr. and Associates to design a building to house a brand new steam plant. And to insure a constant and dependable process steam supply under demands that varied from 28,000 to 73,000 pounds per hour . . . with swings as wide as 16,000 pounds per hour . . . Kerr engineers selected a single B&W Integral-Furnace Boiler, Type FJ, 250 psi, 60,000 lb/hr continuous and 70,000 lb/hr peak load on coal, oil, or gas.

Performance over the three-year period since the change from "Nine to One" more than substantiated the confidence placed in this B&W unit . . . and, just as important, contributed far-reaching economies. Fuel, payroll and maintenance charges were cut sharply . . . savings on fuel alone amount to more than $90,000 a year. Valuable floorspace was released for additional production facilities. *And* . . . with a reliable, ample steam supply available, orders are being scheduled more accurately, while production quality and quantity have reached new highs.

Complete satisfaction with the continuing performance of this unit—even under load conditions exceeding design specifications—was indicated when this company recently installed another B&W Integral-Furnace Boiler, Type FJ. To quote Mr. W. Hunt Fisher, Plant Engineer of Kerr Bleaching, "On the basis of what our present unit has done for us, I am confident that we could not have made a wiser choice for our new one."

To the hundreds of other users of B&W Integral-Furnace Boilers, their economical installation, maintenance, and operation are an old story. (Units producing a total of over 200,000,000 pounds of steam per hour are in service and on order for almost every variety of industry, plant or institution.) If *you* have problems in steam supply for processing, power, or heating, B&W's more than 70 years' experience in boiler construction and application will interest both your plant engineers and cost accountants. The Babcock & Wilcox Company, 161 East 42nd Street, New York 17, N. Y.

COST SAVING FEATURES

of B&W Integral-Furnace Boilers for Steam Requirements from 2,800 to 350,000 Lb. Per Hr.

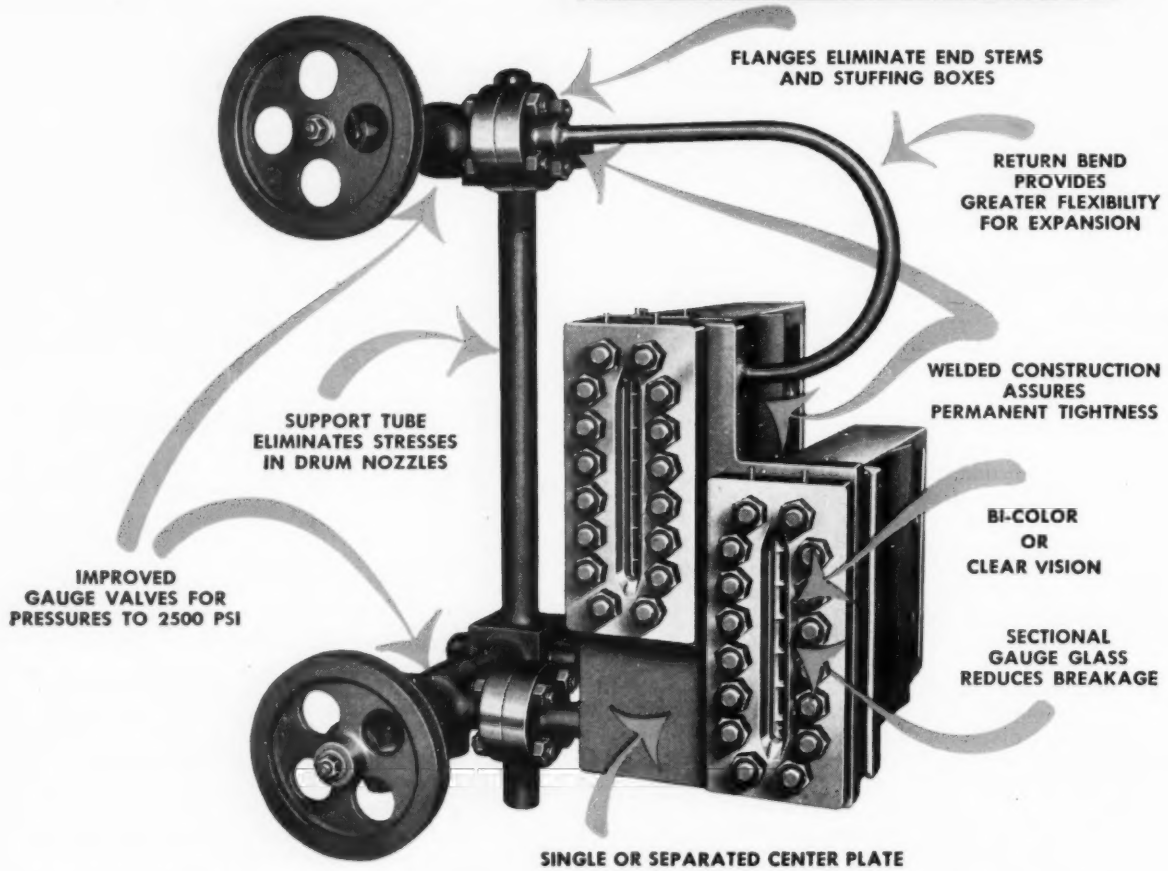
- Minimum floor space and headroom requirements
- High fuel economy
- Smokeless combustion
- Adaptable to all fuels and firing methods
- Economical fast steaming
- Water-cooled furnace
- Clean, dry steam at all ratings, even with high boiler water concentration
- Quick response to wide and heavy load swing demands
- Easy to inspect and clean
- High availability with least attention

B&W

BABCOCK & WILCOX

DIAMOND Flange Connected WATER GAUGES

The Answer to High Pressure Gauge Problems


FLANGES ELIMINATE END STEMS AND STUFFING BOXES
RETURN BEND PROVIDES GREATER FLEXIBILITY FOR EXPANSION
WELDED CONSTRUCTION ASSURES PERMANENT TIGHTNESS
SUPPORT TUBE ELIMINATES STRESSES IN DRUM NOZZLES
BI-COLOR OR CLEAR VISION
IMPROVED GAUGE VALVES FOR PRESSURES TO 2500 PSI
SECTIONAL GAUGE GLASS REDUCES BREAKAGE
SINGLE OR SEPARATED CENTER PLATE

As can be seen in the illustration, this different engineering approach solves three major problems in high pressure water gauges . . . tightness . . . expansion and stress . . . and glass breakage. Additional important advantages are maximum level visibility with minimum nozzle spacing . . . and more accurate reading.

The uninsulated bend provides sufficient condensing area to assure active circulation of hot condensate through the gauge. This maintains the gauge at higher temperature so there is less difference between boiler water and gauge water density. That and the shorter gauge assure greater accuracy.

These gauges are available in either Bi-Color or clear vision construction. Ask for Bulletin No. 1051U, Diamond Water Gauges and Water Columns.

6545

DIAMOND POWER SPECIALTY CORPORATION

50th ANNIVERSARY 1903-1953

LANCASTER, OHIO

Diamond Specialty Limited — Windsor, Ontario

DIAMOND BI-COLOR WATER GAUGE

WITH "HI-LITE" Illuminator

"You're Always SURE with Bi-Color"

There is no guessing about boiler water level when you use the Diamond Bi-Color Water Gauge. It makes use of an unvarying optical principle (the difference in refraction between water and steam) to always show water green . . . steam red. With proper illumination, the water level is unmistakable . . . whether viewed directly . . . through a system of mirrors . . . or on control panel by use of Diamond "Utiliscope" (Wired Television).

MORE Visibility with LESS Cleaning

A big improvement over other light sources, the "Hi-Lite" Illuminator uses standard high-intensity lamps similar to automobile "sealed beam" headlights. The gauge will thus retain visibility with much longer time between gauge cleaning . . . it remains easily and clearly visible when dirty mica would otherwise make reading difficult. The lamps have sealed-in reflectors which cannot get dirty. The lamp faces are easily reached for cleaning . . . as are all other parts of the illuminator.

Bulletin No. U1051 gives interesting information about Diamond water gauges, water columns and accessories. Write for a copy.

50th ANNIVERSARY 1903-1953

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
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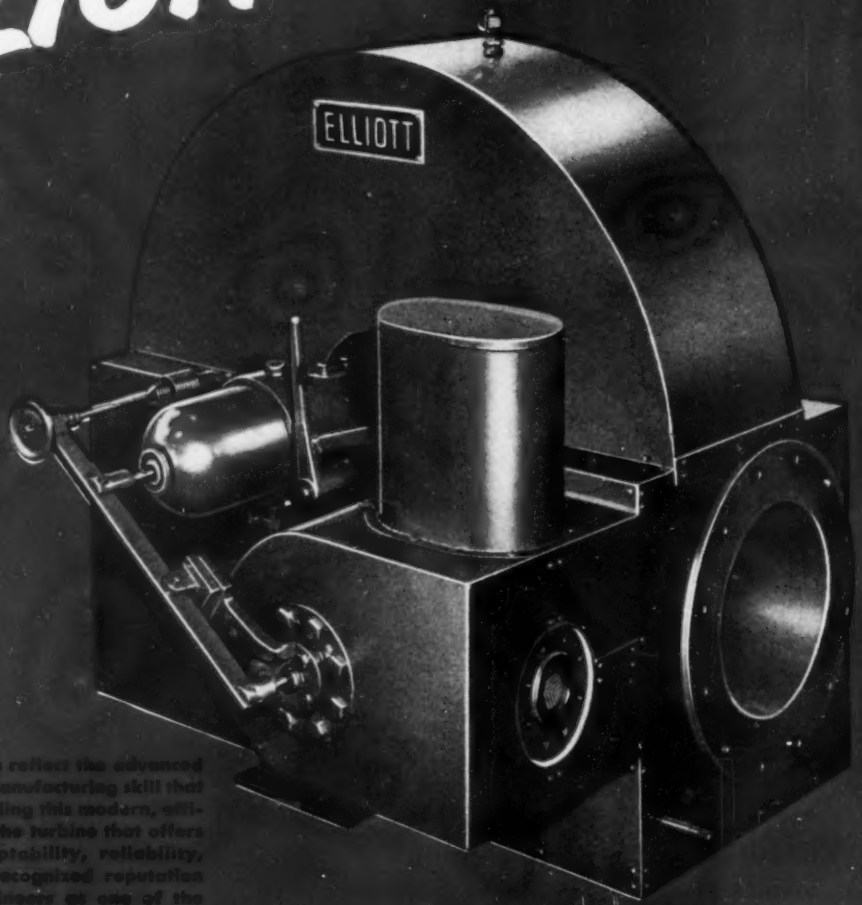
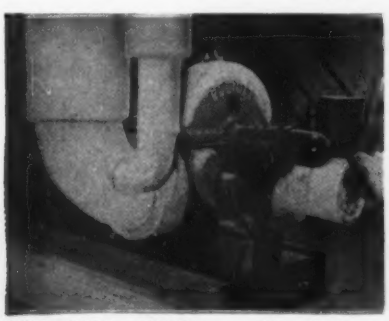
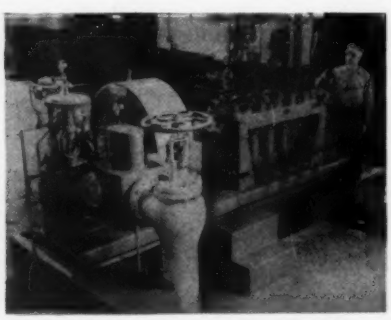
ELLIOTT TURBINES



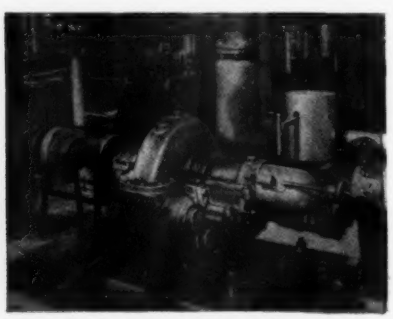
Clean, simple lines reflect the advanced engineering and manufacturing skill that has gone into building this modern, efficient turbine. It's the turbine that offers everything—adaptability, reliability, economy and a recognized reputation among plant engineers as one of the finest, most dependable turbines available anywhere.



Elliott 360-hp, 3550-rpm turbine driving a boiler-feed pump in a paper mill, exhaust steam being used in process.



Elliott 500-hp turbine driving a hydraulic system pump in a steel mill. Turbine maintains constant pump discharge pressure.



One of a group of Elliott turbines driving lean oil pumps in a cycling plant, where reliability is especially important.

A standard turbine— yet "tailor-made" to your requirements

Elliott Turbines can be adapted to practically any operating condition or service

That's because these powerful, compact turbines are designed to give you the advantages of custom-built adaptability at savings achieved through mass production of standardized parts. A wide variety of permissible modifications are possible. For instance... five sizes of YR turbines cover the entire range of capacities up to 2000 hp, speeds from 800 to 7000 rpm and back pressures from 4 in. Hg to 250 psig. Standard designs of rotor, governor, bearings, bearing cases, steam chest, governor valves and governor linkage are used throughout. In the case of higher pressures and temperatures up to 850 psig and 900 F, materials for steam parts may be changed from cast iron to steel.

Here are a few of the design highlights that are included in Elliott turbines:

Air-wall labyrinth seals to protect bearings from contamination without rubbing contact.

Centerline support to provide constant alignment under any operating condition.

Stainless steel spray coating under packing glands to eliminate corrosion of the shaft.

Choice of many governors to meet specific control requirements.

Liner type bearings to eliminate the need for scraping and fitting.

Packing glands removable without raising turbine upper half casing to simplify inspection and maintenance operations.

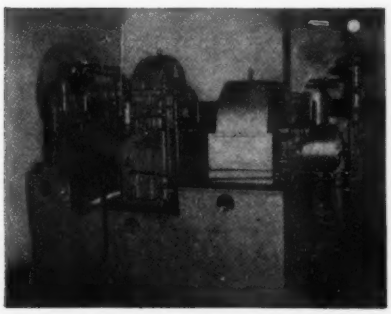
Stainless steel buckets and shroud to assure maximum life and continued high efficiency.

These and many other features are *standard* in Elliott turbines. They are the result of years of practical experience in the application of turbines to hundreds of different types of plant equipment and to many different types of operating and steam requirements.

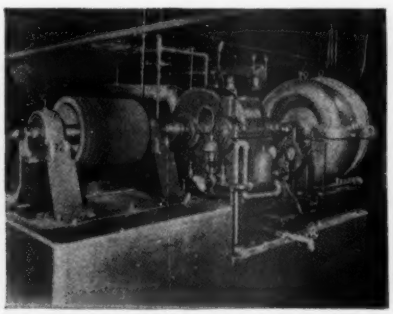
Full details on Elliott Mechanical Drive Turbines can be obtained from your local Elliott representative or by writing Elliott Company, Jeannette, Pa., for a descriptive bulletin.

ELLIOTT Company
STEAM TURBINE DEPARTMENT

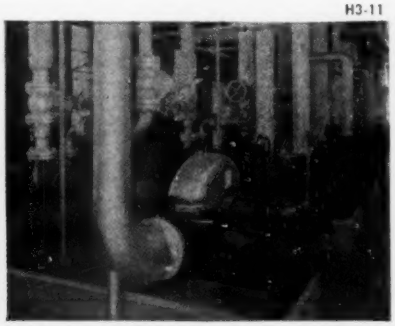
H3-11



This Elliott 202-hp turbine drives an induced-draft fan through a separate reduction gear, in a midwestern generating station.



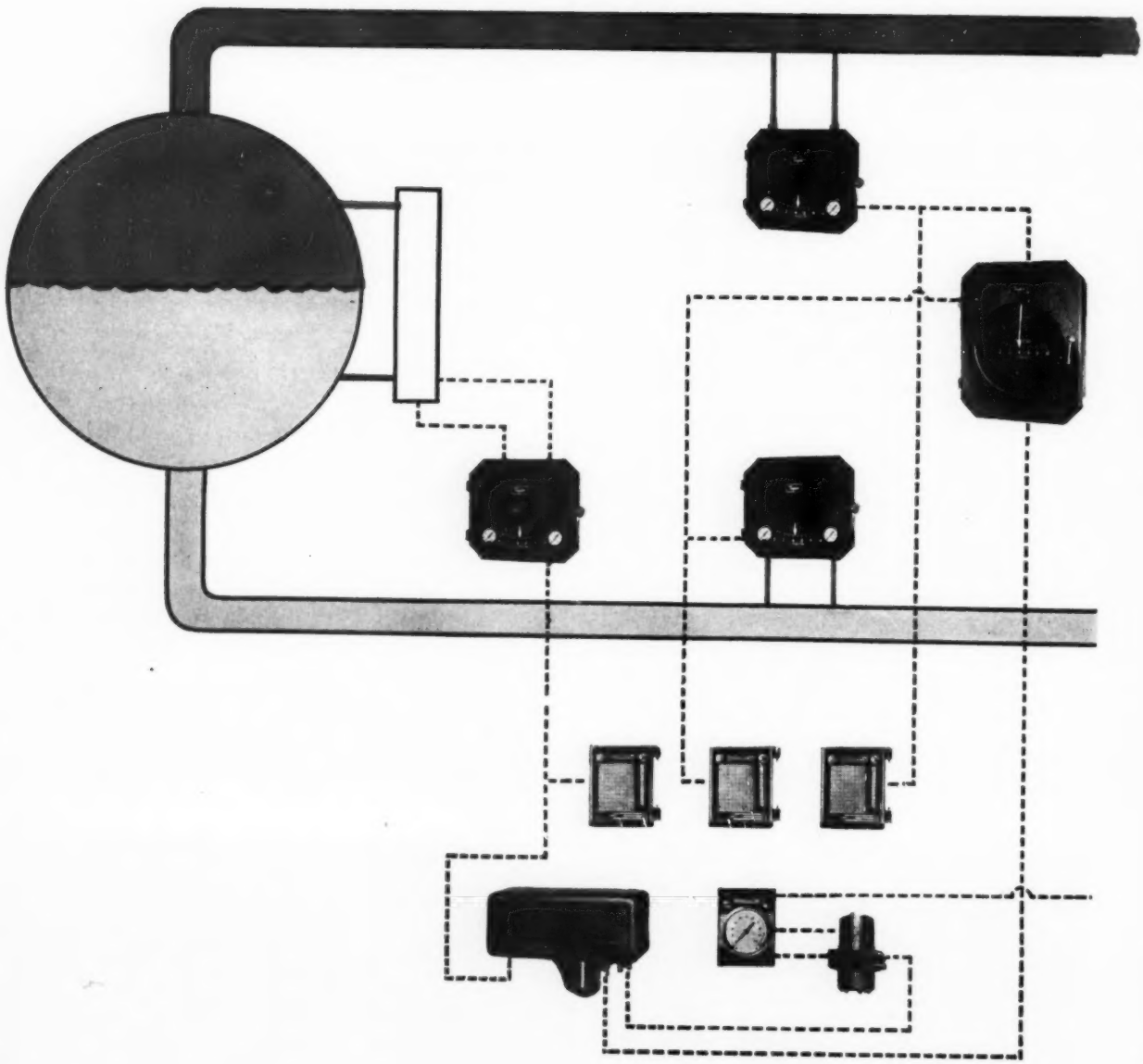
An Elliott 250-hp geared multi-stage turbine driving a paper machine. Governor gives close regulation over a wide speed range.



This line of oil pumps is driven by Elliott turbines. This is one of many refinery applications for Elliott turbines.

From the oldest

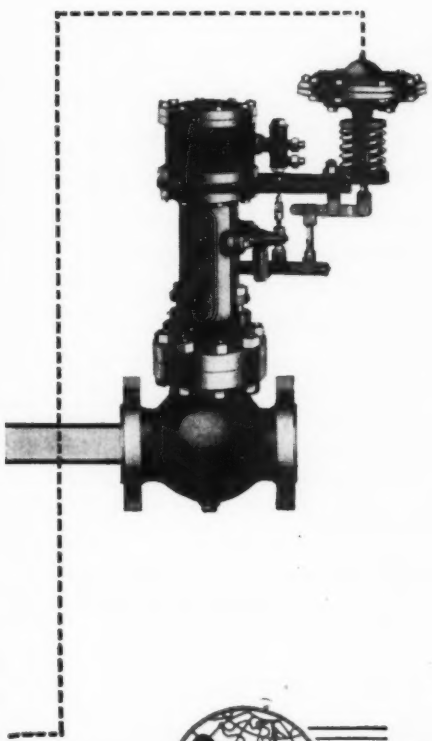
IN THREE-INFLUENCE



comes the newest

BOILER FEED WATER CONTROL

COPES type 3-L with instrumentation by Taylor



COPES . . . the *oldest* name in boiler feed water regulation . . . now offers you the *newest* in three-influence feed water control. Combined in the new COPES Type 3-L are . . .

. . . the scientific balance, the characterized ports and the rugged dependability of the COPES control valve

. . . plus the unequalled responsiveness and accuracy of *instrumentation by Taylor*

And Copes-Vulcan assumes undivided responsibility for service, whenever or wherever needed . . . throughout the life of the installation. *Write for Bulletin 1013.* It tells the story of the newest feed water control to come from COPES . . . the oldest name in boiler feed water regulation.

COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

ERIE 4, PENNSYLVANIA

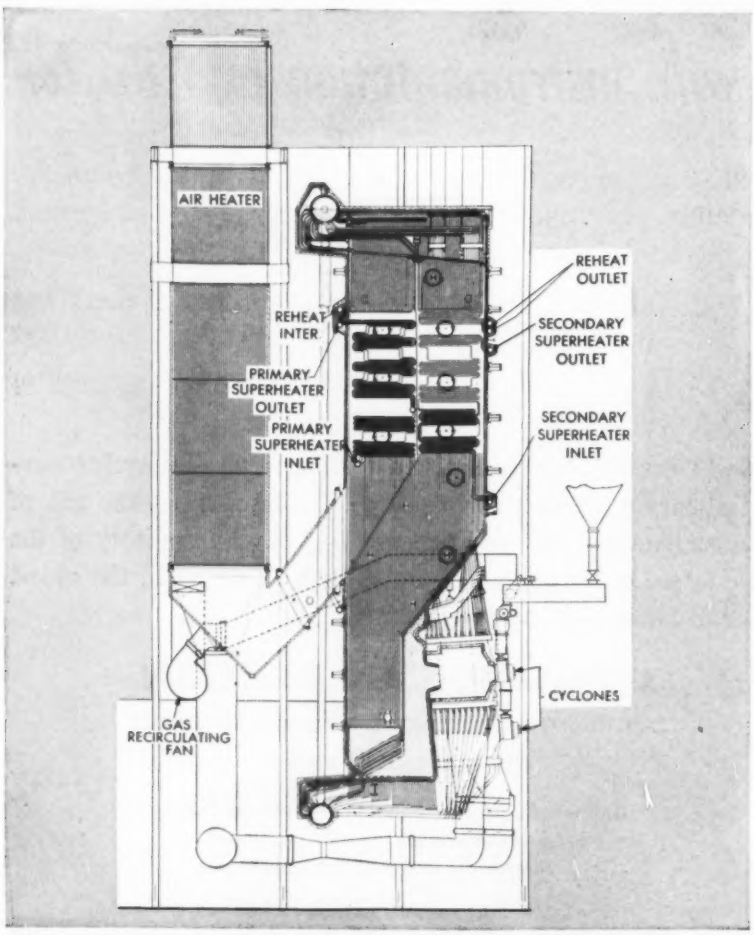
Three-influence mechanically-operated and three-influence electrically-operated regulators are also available.

COPES VULCAN BOILER CONTROL

WITH INSTRUMENTATION BY Taylor

OHIO EDISON COMPANY

for Two Cyclone-fired pressurized-furnace



Steam Generators (2). . Babcock & Wilcox

Type. . . . . Radiant, with reheater

Maximum Capacity. . . . 885,000 lb per hr

Superheater Outlet Pressure. . . . 1485 psig

Final Superheated Steam Temperature 1000 F

Reheat Steam Temperature. . . . . 1000 F

Fired with. . . . . Crushed coal; cyclone fired, pressurized furnace

Soot Blowing. . Vulcan Automatic-Sequential System with air-powered long retracts and electric-driven traveling-frame air-preheater cleaners. Blowing medium for all units: air.

Design Engineers. . . . . Commonwealth Associates, Incorporated

VULCAN *Automatic*

INSTALLS VULCAN

reheat steam generators at NILES STATION

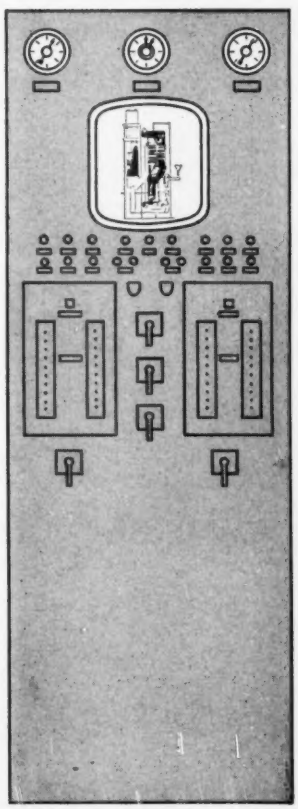
PLANNED for functional design and operating efficiency, the new Niles Station will add 212,000 kilowatts to Ohio Edison Company's system capacity.

Boiler cleaning will be by Vulcan long retractables and traveling-frame—indexing and air-blasting—air-preheater cleaners They are designed to keep even the most inaccessible areas free from deposits that would cut boiler efficiency.

Whether your boilers be large or small, utility or industrial, power or process—depend on Vulcan to clean them effectively, at low overall cost.

And Vulcan Automatic-Sequential Control will reduce soot blowing to a mere matter of setting up the program at a central panel.

COPES-VULCAN DIVISION
CONTINENTAL FOUNDRY & MACHINE COMPANY
ERIE, PENNSYLVANIA



The operator sees the report of each blower as it works in automatic or selective sequence, or manually, as he pushes the right button.

How to Increase the Return on

FORMULA for Cutting Production Costs

(BAILEY Design) + (BAILEY Engineering) + (BAILEY Service)

= GREATER SAVINGS PER FUEL DOLLAR

Control Center for 60,000 kw reheat boiler-turbine Unit No. 1 at Danskammer Point Steam Station of Central Hudson Gas & Electric Corp. Bailey MINI-LINE Equipment on benchboard gives operators fingertip control while larger recorders on vertical board show operating trends and make permanent records. Duplicate Bailey Equipment has been purchased for Unit No. 2.

Engineering and construction by Burns and Roe, Inc.

Your Boiler Room Investment

★ There are four important ways to increase the return on your Boiler Room Investment:

More power per fuel dollar
Less outage
Delivery of steam at design conditions
Greater operating safety

None of these items taken alone will produce the highest return—it takes all four working in close harmony.

That's where co-ordinated controls by Bailey Meter Company help. And here is why Bailey Controls are your best choice:

1. Complete Range of Equipment—fully co-ordinated. You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. Engineering Service—backed by experience. No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement, and automatic control.

3. Direct Sales-Service—conveniently located near you. Bailey Meter Company's Sales-Service Engineers are located in more Industrial Centers than those of any other manufacturer of Boiler Control Systems; you get prompt, experienced service with a minimum of travel-time and expense.

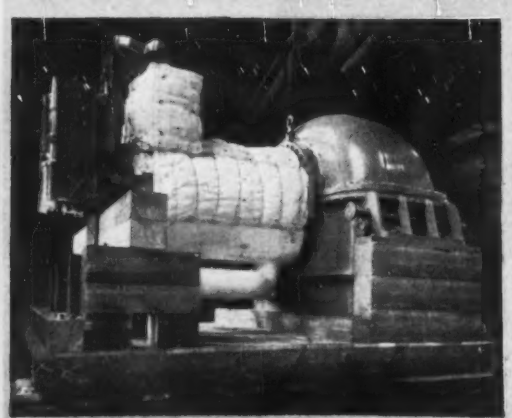
For better "boiler-room investment" efficiency—for more power per fuel dollar, less outage, steam at design conditions, and greater operating safety—you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More Power To You!"

A-115-2

BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

Another

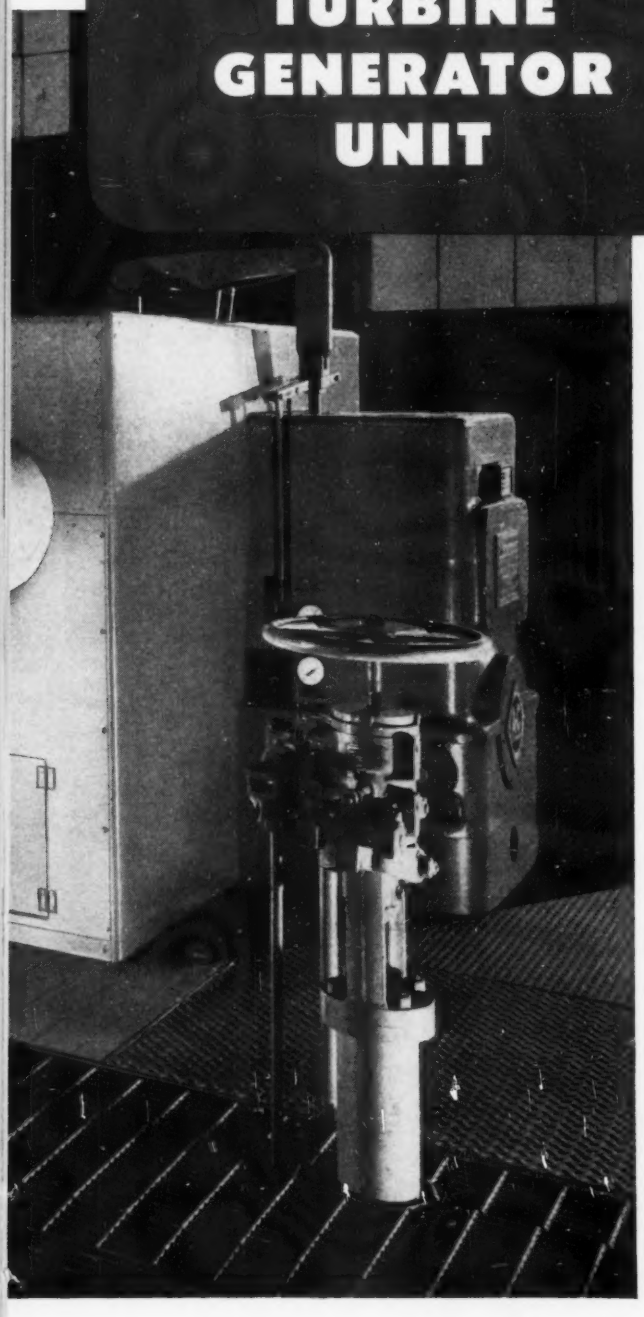


To simplify installation, both turbine and generator are shipped as complete assemblies with rotors locked in place. Turbine insulation is also applied at factory. Illustration at left shows 7500-kw turbine ready to be covered with tarpaulin before shipment.

Attractive appearance of WA-Series turbine and generator is shown above. Unit is rated 7500 kw, with steam conditions of 600 psig, 825 F, 1½ inches mercury absolute. A-C also supplied surface condenser, pumps and motors for this installation.

WA-Series

STEAM TURBINE GENERATOR UNIT



Engineered to Meet Requirements of a Modern Power Plant!

HERE'S another Allis-Chalmers WA-Series turbine generator unit with the kind of design features and performance that power producers everywhere are looking for today.

Available for condensing and non-condensing service, the up-to-date WA-Series impulse turbine design is built in sizes 2000 kw and larger in NEMA standard ratings. Basic engineering features include labyrinth steam seals throughout, removable external glands, high chrome alloy steel buckets and nozzles, and time-proved governing system.

Simplicity is Keynote

For ease of installation and maintenance, every detail has been designed to assure maximum simplicity. Three-bearing construction; above-the-floor oil piping; bracket-bearing, housing-type air-cooled generator — all result in a compact unit with simple foundation requirements. And shipment of the turbine and the generator with their rotors in place further minimizes installation costs.

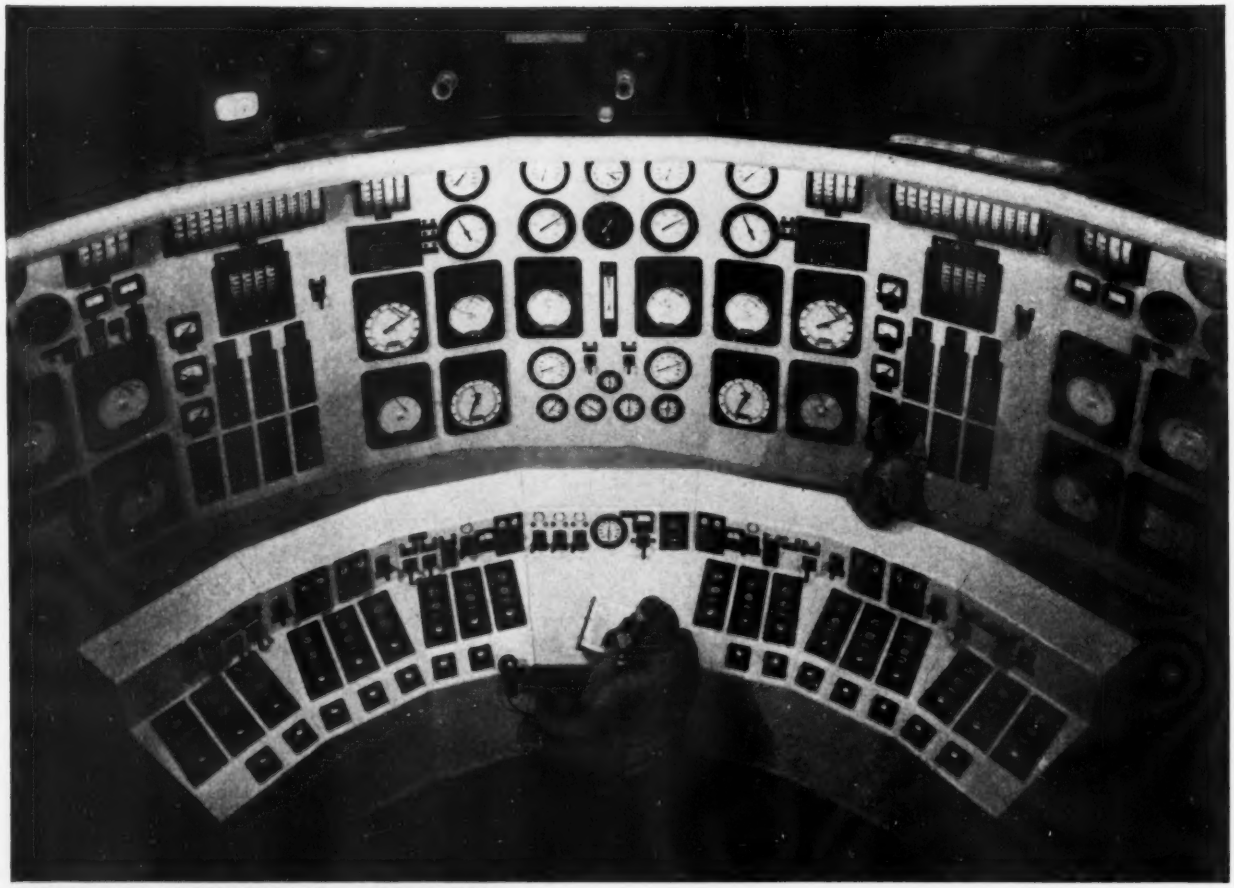
Completely coordinated in design, these modern generating units are manufactured, assembled and tested in one plant under unified supervision.

For a detailed story of the WA-Series features that can help you reduce costs, ask your A-C representative for Bulletin 03B7654, or write to Allis-Chalmers, Milwaukee 1, Wis.

A-4112

ALLIS-CHALMERS

A-C ALLIS-CHALMERS



PRESSURE REDUCING STATIONS in the plant are controlled automatically or manually, as desired. The two stations shown include Republic pressure reducing valves which are controlled from a master pressure regulator. Desuperheater stations, controls for feed-water pumps and discharge valves, and flow meters were also furnished by Republic for this modern power plant.

FOUR CYCLONES AT HIS FINGER-TIPS

Two 400,000 lbs./hr. boilers fired by four cyclone furnaces are checked and controlled from this central control point. Republic sub-panels on the control bench board are provided for transferring between automatic and manual operation. Also included are Republic biasing sub-panels for adjusting coal-air ratio, primary-secondary air, cyclone ratio and boiler rating.

They're Harnessing Cyclones....

with REPUBLIC *Automatic* COMBUSTION CONTROL

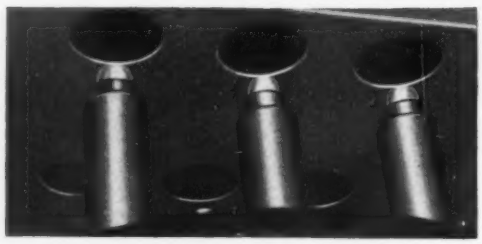
At a major chemical plant, the first 100% cyclone-fired industrial power plant in the country is being controlled for maximum combustion efficiency by Republic combustion controls. The plant produces 800,000 lbs. of steam per hr. at 1250 psi and 830° F. Steam is supplied to both chemical processes and to a 30,000 kw double-extraction turbine generator.

This cyclone-fired plant serves as *additional proof* that Republic combustion control systems can be adapted for *any* type of fuel firing. There are Republic combustion control systems for all sizes and types of boilers, all arrangements of draft equipment and for all load conditions. There's an experienced engineering staff* to help you get the combustion control system that best fits *your* needs.

For full information, write for Data Book S-21 or contact your nearby Republic field engineer.

*For more than 37 years, Republic has *specialized* in the design and manufacture of combustion control systems for all sizes of power generating stations.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS



With G-E vertical lift, you can see when the breaker disconnects

Maximum safety to operator and equipment is provided. Mechanically operated shutters of insulating material close off disconnect openings when breaker is lowered. Stationary contacts are never exposed, present no safety hazard. Shutters open as breaker is raised, permitting entrance of breaker studs.

On G-E Metal-clad Switchgear—

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

New safer, fast-action elevating mechanism can raise or lower breaker in 30 seconds

Vertical-lift design isolates breaker, simplifies inspection

Smooth, practically effortless raising or lowering of the breaker in General Electric's improved metal-clad switchgear, whether for inspection or test . . .

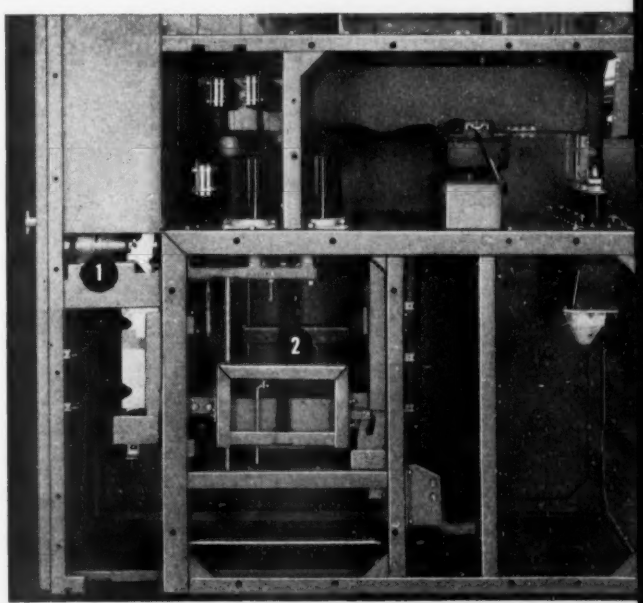
That is what you get with one of the simplest elevating mechanisms possible for the job: two jack screws—a sturdy cross chain drive—a compact gear motor with operating switches.

POSITIVE-ACTING MECHANICAL INTERLOCKS assure speedier operation. An interlocking system effectively blocks raising or lowering a "closed" breaker. In the operating position, the circuit breaker is locked in, preventing downward movement caused by even the most severe vibration. All parts of the elevating mechanism are accessible at front of the compartment, with the motor easily demountable for hand-crank operation.

BESIDES THESE ADVANTAGES of the new, faster-acting breaker-elevating mechanism, you also get full benefits of G.E.'s basic vertical-lift design. You can—

- See when breaker is isolated and breaker studs separated from main stationary contacts. Mechanically operated shutters close off disconnect openings to protect operator.
- Close the door with breaker in lowered position.
- Make most inspections and tests with breaker just lowered—not removed from compartment.
- Save time and energy, as mechanical lift makes removal of breakers convenient and easy.
- Gain quick, easy access to breakers in outdoor installations—especially on roofs where catwalks make other types of breaker removal inconvenient.

FOR THE COMPLETE STORY on G-E Vertical-lift Metal-clad switchgear, with ratings up to 13.8 kv, 500 mva, write for GEA-5664-A, Sect. 874-4, General Electric Company, Schenectady 5, N. Y.

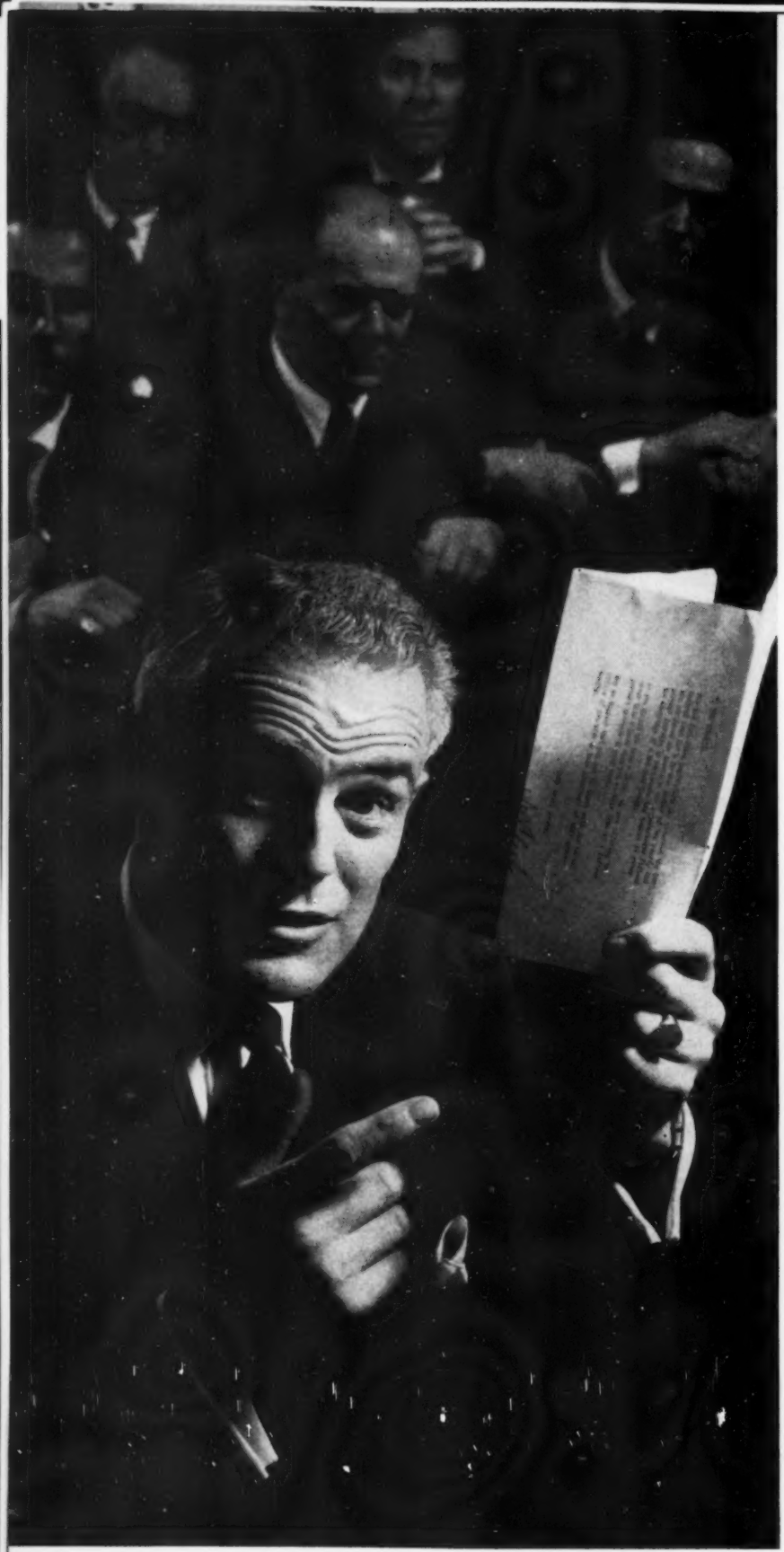


NEW ELEVATING MECHANISM is shown in breaker with side plates removed. Compact gear-motor (1) in front of the compartment drives simplified jack screw mechanism (2) to raise breaker.

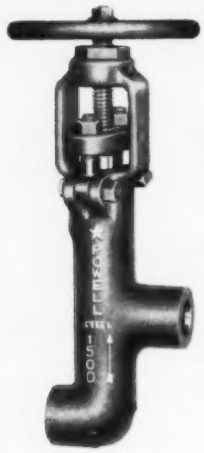
VERTICAL-LIFT DESIGN proves invaluable in outdoor switchgear installations—enables personnel to disconnect and inspect breakers easily in spite of gravel or other obstacles.

You can put your confidence in—

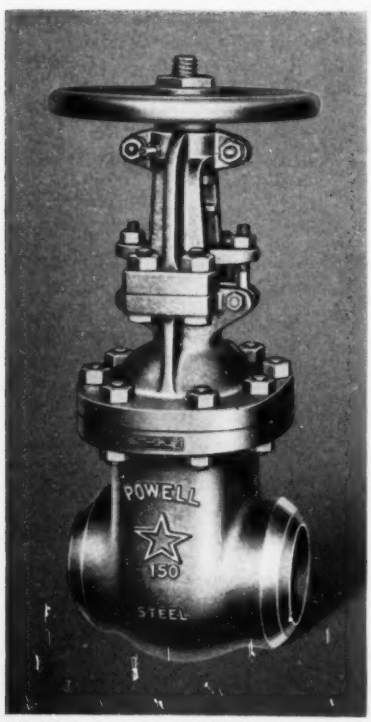
GENERAL ELECTRIC



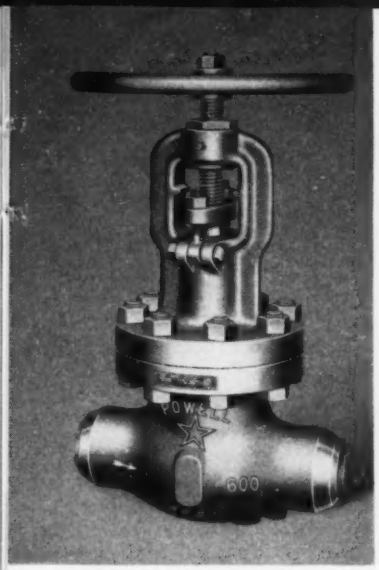
INTEGRAL BONNET OFFSET GLOBE VALVE *(Fig. 1331-A).* 1500-pound. One-piece construction eliminates possibility of leakage between body and bonnet. Sizes ½" to 2", inclusive.



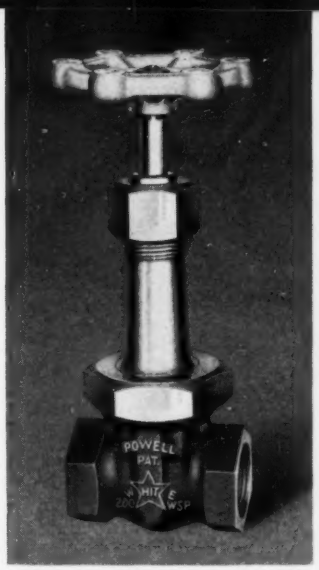
AN OPEN



WELDING END CAST STEEL GATE VALVE *(Fig. 1503 WE).* 150 pounds. Bolted Flanged Bonnet with outside screw rising stem and yoke. Available in sizes 1" to 30", inclusive.



WELDING END STEEL GLOBE VALVE *(Fig. 6031 WE).* 600-pound. Bolted flanged yoke. Available for either steam service or oil service in sizes ½" to 12", inclusive.



BRONZE "WHITE STAR" GATE VALVE *(Fig. 375)* for 200 pounds W.S.P. Union bonnet with inside screw rising stem. Renewable "Powellium" Nickel-Bronze wedge.

AND SHUT CASE

All the evidence is in. Powell Valves have a record of dependability since 1846. Powell makes more types of valves, has probably done more valve research and solved more valve problems than any other organization in the world.

On the basis of such overwhelming evidence, can your verdict be anything but a decision in favor of Powell Valves? See exhibits following.

SWING CHECK VALVE *(Fig. 559)* for 125-pounds W.S.P. Iron body, bronze mounted. Regrindable, renewable bronze seat and disc. Sizes 2" to 16", inclusive.

PRESSURE SEAL GATE VALVE *(Fig. 19003).* 900-pound. Many proven advantages and exclusive features. Pressure Seal valves are available in Non-Return, Check, Globe and Angle Patterns.

P V

New!

In our seventy-six years of fan manufacturing, no fan has been more respected for fine performance than the "Buffalo" Type "LL" Ventilating Fan.

This fine performance is now further improved in the new "Buffalo" Type "BL" Limit Load Fan — designed especially for general ventilation, air conditioning and industrial service.

This new fan offers:

(1) High efficiency

(2) Minimum noise level, over wide capacity range

(3) Full Limit-Load horsepower characteristic

(4) Stable performance from shut-off to free delivery

Retaining the husky construction which has characterized "Buffalo" fans for many years, the new Type "BL" has some outstanding quality design features.

The fan inlet is die-formed of heavy gauge steel, with die-formed inlet vanes welded in place. This permits the Type "BL" to give rated performance despite unfavorable inlet conditions frequently present on industrial jobs. Rotor construction includes a die-formed shroud and die-formed blades of backward curvature, so that the resulting self-limiting horsepower characteristic permits selection of driving motors of minimum horsepower.

The Type "BL" fan will be built in standard sizes and arrangements, with rotor diameters from 12¼" to 108¾", to handle from 1,000 to 500,000 cfm.

You will want this superbly-performing new fan with the "Q" Factor* on your next job! Write for new Bulletin F-100, which contains complete engineering details, including performance tables and dimensions.

**The "Q" Factor — The built-in Quality which provides trouble-free satisfaction and long life.*

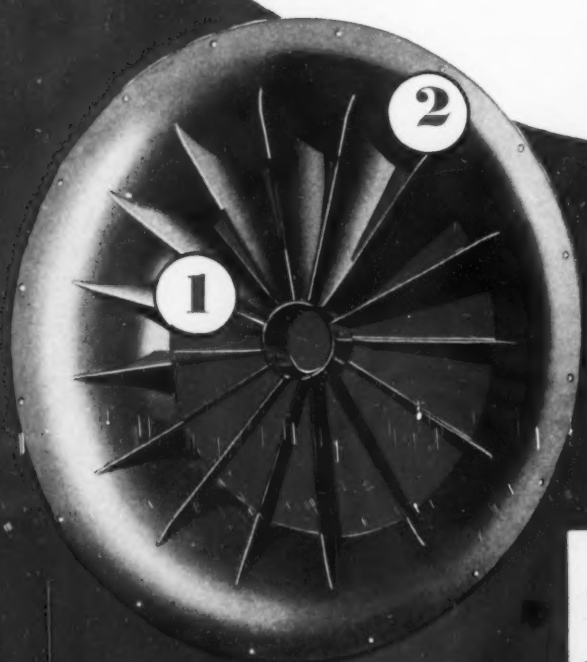
BUFFALO FORGE COMPANY

488 BROADWAY BUFFALO, NEW YORK

PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Sales Representatives in all Principal Cities



"Buffalo"

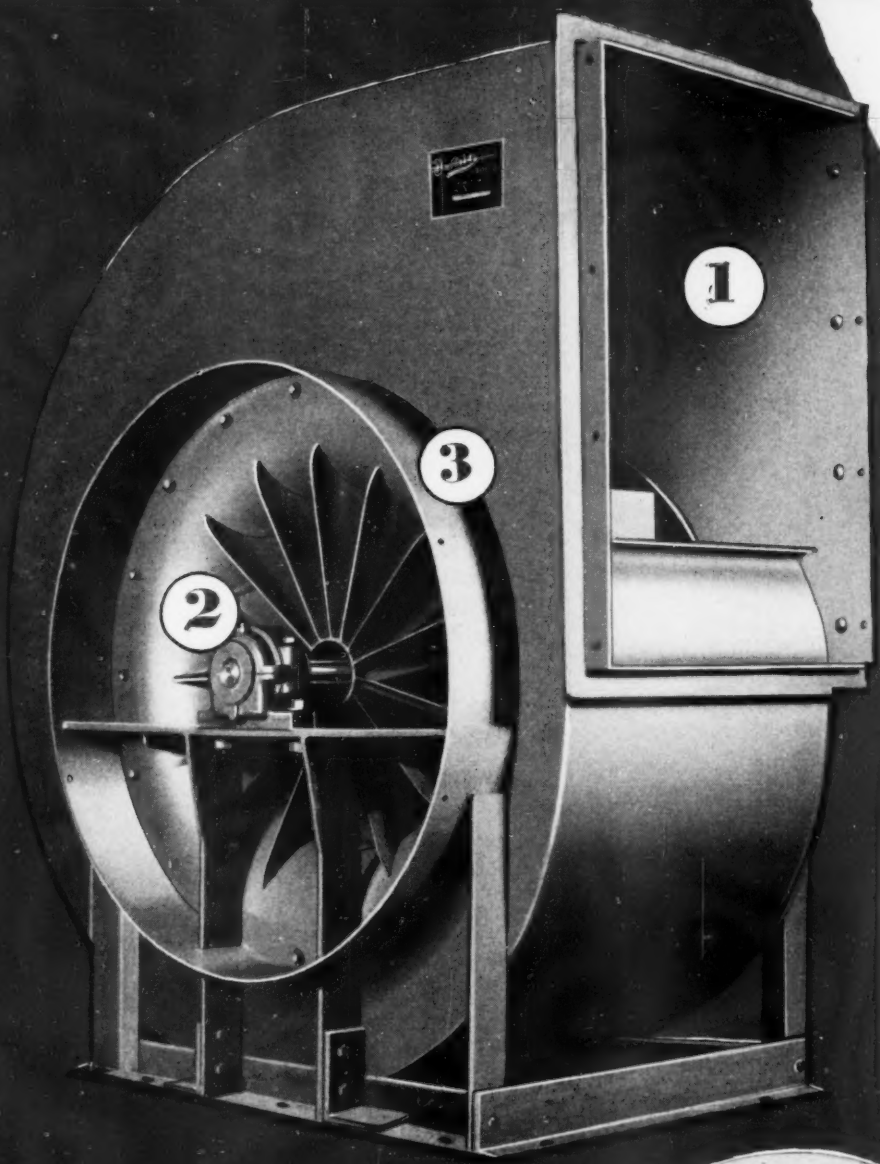
TYPE "BL"

Limit-load FAN

INLET

1 Furnished as standard, and exclusive with "Buffalo", these stationary inlet vanes reduce turbulence and assure rated air delivery in spite of unfavorable inlet conditions.

2 Die-formed inlet bell matches wheel shroud.



COMPLETE FAN

1 Streamlined housing with outlet designed for most efficient air delivery.

2 Anti-friction or sleeve bearings to suit job requirements.

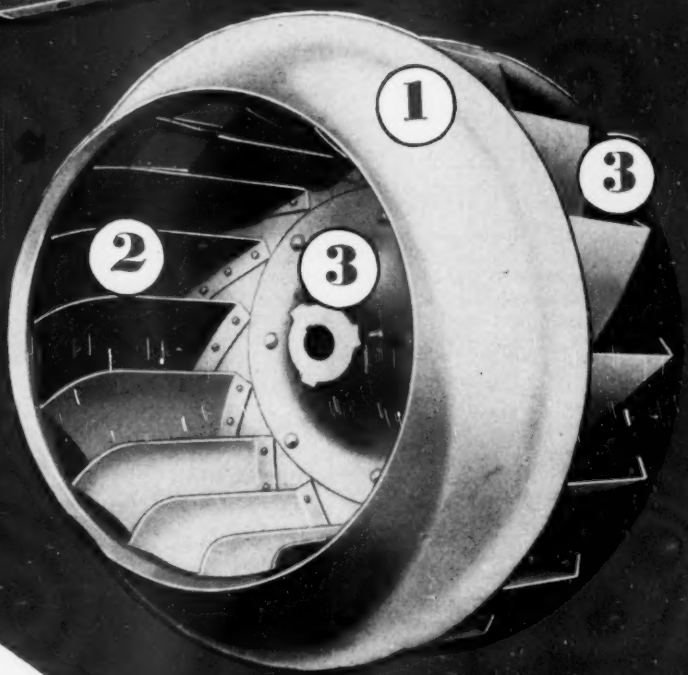
3 Ample inlet collar for easy connection to ductwork.

WHEEL

1 Heavy gauge die formed shroud, full curvature for proper air flow in wheel.

2 Die formed blades curved and backwardly inclined for stable air flow. Welded and riveted for maximum strength.

3 Solid back plate with extra heavy hub.



CERTIFIED RATINGS

Certified ratings are the result of tests made by the Manufacturer in accordance with the Standard Test Code for Centrifugal, Axial and Propeller Fans Adopted jointly by the National Association of Fan Manufacturers and the American Society of Heating and Ventilating Engineers.

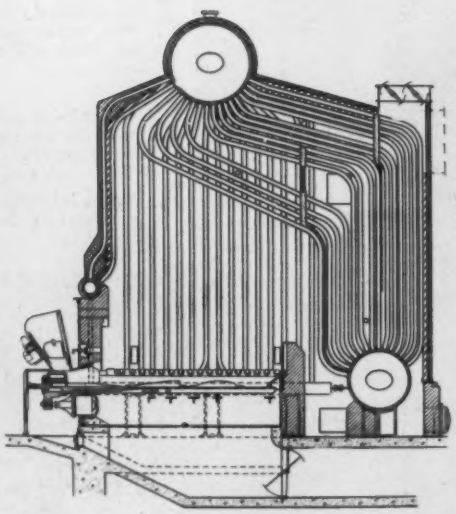
AUTHORIZED BY N A F M

© 1948 NATIONAL ASSOCIATION OF FAN MFGRS.

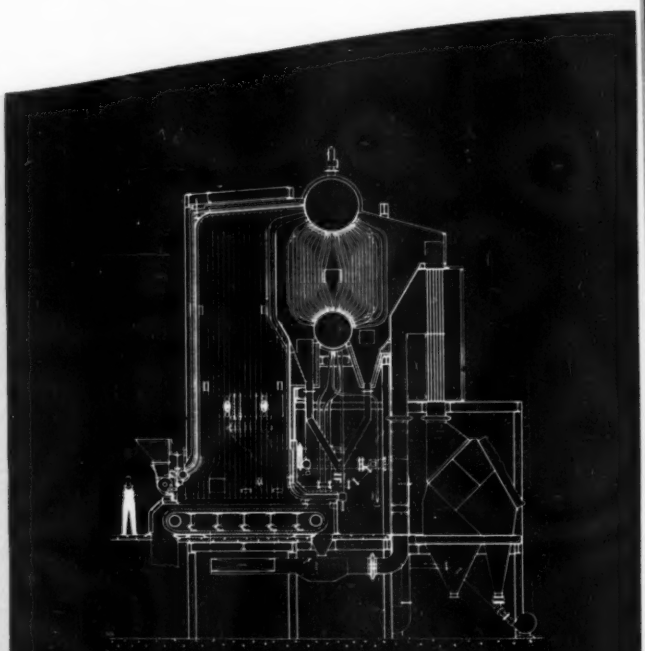
VU Utility Standards

Electric utility companies maintain the highest equipment standards in the power generation field. Kilowatts are their business — their product . . . to be turned out reliably, efficiently and at the lowest possible cost. To assure this they demand — and get — the most reliable — the most efficient — the best built boilers that the market affords.

To meet their highly critical standards the utilities have long been accustomed to purchase steam generating units that were, in large measure, individually designed to meet their particular needs.



VU-10 Boiler — This unit is installed in a hosiery mill. It is fired by a Type E Underfeed Stoker. Capacity — 12,500 lb steam per hr; operating pressure — 100 psi; no superheat. VU-10 Boilers are available in sizes from 10,000 to 60,000 lb of steam per hr.



VU-40 Unit — One of seven, now being installed in a Chemical Plant. These boilers will be fired with C-E Spreader Stokers (continuous discharge type). The capacity of each is 60,000 lb of steam per hr at an operating pressure of 325 psi. There is no superheat.

COMBUSTION

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT

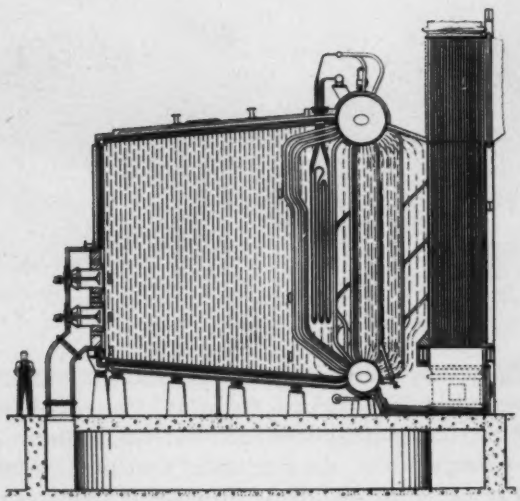
in a Standard Boiler

And C-E Vertical-Unit Boilers, particularly in the larger sizes, are available in "custom-made" designs to suit specific requirements. In fact, VU Units have been a popular choice with utility companies for many years.

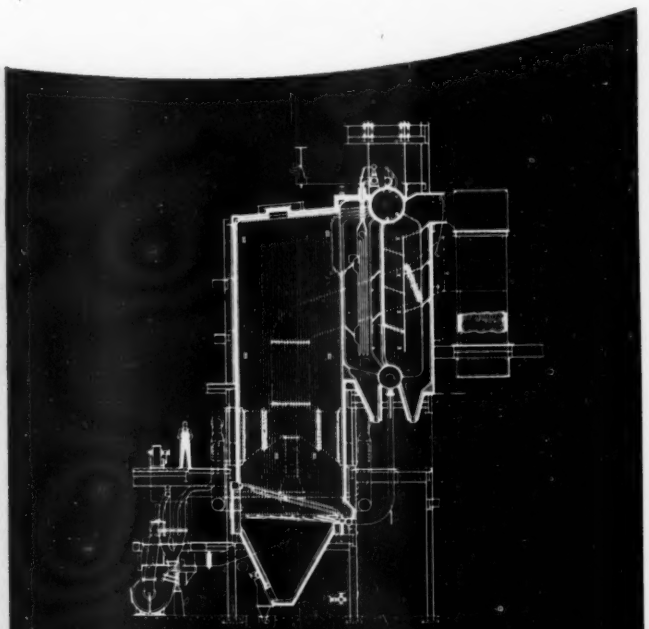
But many other designs that comprise the "VU family" are completely *standardized* . . . standardized without sacrifice of "custom-made" advantages. And when you standardize you reduce engineering costs, reduce manufacturing costs, reduce erection costs — in short, you save money.

Here then is a line of custom-quality boilers with all the benefits of standardization built in capacities from 10,000 lb of steam per hr up, for any pressure and temperature . . . and suitable for any type of fuel burning equipment.

Little wonder that industry — all industry — has found within the VU family a boiler unit exactly suited to its needs. Breweries and hosiery mills, chemical companies and steel plants — all have installed VU Boilers again and again with complete satisfaction. So can you.



VU-50 Boiler — This unit is one of two duplicates installed in a brewery. They are fired with oil or gas. Capacity — 100,000 lb of steam per hr; operating pressure 550 psi; steam temperature 700 F. This particular design is of the bottom-supported type.



VU-50 Boiler — This unit, one of five duplicates, is in service in a large tube mill. It is designed to burn pulverized coal and blast furnace gas. Capacity — 175,000 lb steam per hr; operating pressure — 850 psi; steam temperature 750 F.

ENGINEERING, Inc.

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

C-E

8-649

HALL INDUSTRIAL WATER REPORT

Hall Laboratories, Inc.—A Subsidiary of Hagan Corporation, Pittsburgh, Pa.

Volume 1 | OCTOBER 1953 | Number 5

Expert Knowledge Solves Process Problems

A hurry-up call from a Hall field engineer sent C. T. Roland, Pittsburgh headquarters expert on metal preparation and paint finishing to confer with a west coast automobile plant on a paint blistering problem. The sudden occurrence of the blistering baffled the plant engineers until Roland investigated the possibility of a change in the source of the water used in final rinsing of the metal before paint was applied. He found that the quality of the water supply had changed shortly before the blistering developed. Analysis showed that this supply was higher in pH and dissolved solids, particularly sodium chloride, than the water previously used. Mr. Roland's experience in dealing with the action of soluble salts under paint films led to the conclusion that in this case the paint was acting as a semi-permeable membrane, allowing the passage of moisture from the outside surface of the paint to the salty underlayers. Blisters formed wherever the osmotic pressure of the salt solution exceeded the bond of the paint to the metal. The higher alkalinity of the water contributed to the loss of adhesion, promoting further separation of the finish from the metal.

With the cause for the trouble established, recommendations were made to obtain a water supply low in solids until the plant could install equipment to insure the constant delivery of water of suitable quality for this operation.

In another case where specialized knowledge was useful, Ralph Thompson, specialist on paper manufacturing processes, was called in to help a paper mill out of a jam. Their calender rolls, the polished steel rolls that "iron" paper smooth, were corroding. Regrinding to polish the rolls was costly.

Mr. Thompson's on-the-spot investigation revealed that too much alum was being used in the sizing. Alum feed was reduced and the process water was treated with a glassy phosphate corrosion inhibitor. When reliable controls of the modified process were set up, corrosion disappeared.

Water Well Capacity Increased by Treatment With Glassy Phosphate

Initial capacity of new municipal well was recently increased 63% by treatment with Calgon.* Other new wells in the field developed capacity increases up to 34%. In an old well where the capacity had fallen to only 9.5 gallons per minute per foot of drawdown, one charge of Calgon raised the capacity to 31.2 gallons per minute per foot of drawdown, an increase of 228%.

In another case, after acid cleaning had restored a municipal well to approximately the same capacity it had when new, a single charge of Calgon raised the capacity by 100%, or about twice the original capacity of the well.

The dispersive action of glassy phosphate is responsible for its efficiency as a well cleaner. Cleaning with inhibited acid removes deposits of calcium carbonate and iron oxide, but will not affect accumulations of clay, quartz, amorphous silica, mica or silt. These latter are also dispersed and removed by Calgon cleaning.

Hall Is Water Consultant For Asia's Greatest Power Station

India's $35 million power plant, 200 miles north of Calcutta in the Damodar Valley, began operation in February. This is part of an extensive project to hasten the industrial development of a ¼-million square mile area of India.

Alex Henricks, staff engineer serving as consultant for India's new power plant, lifts water sample from container marked "This Package Opened and Examined by Customs at Calcutta."

Engineers and constructors of the station, The Kuljian Engineering Corporation of Philadelphia, have retained Hall Laboratories, Inc. as water consultants.

Industrial Water Problems Require Special Handling

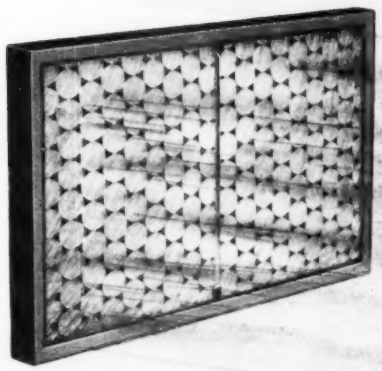
There are no "stock answers" to industrial water problems. For information write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

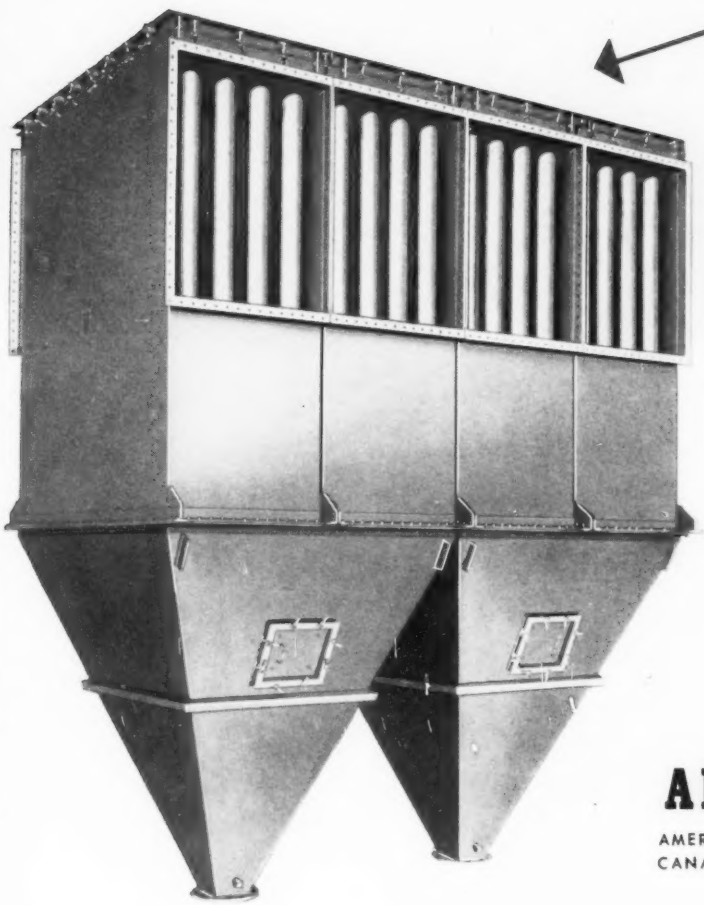
Water is your industry's most important raw material. Don't waste it.

*Calgon is a registered trademark.

American Blower . . . a time-honored name in air handling

This forced-air furnace filter catches particles of dust and dirt that otherwise would be carried into the home.





This American Blower Fly Ash Precipitator collects the fly ash that otherwise would settle on the surrounding area from boilers in power plants burning solid fuels.

Both products aid materially in the American plan for better living.

AMERICAN BLOWER

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO

Division of American Radiator & Standard Sanitary Corporation

Serving home and industry

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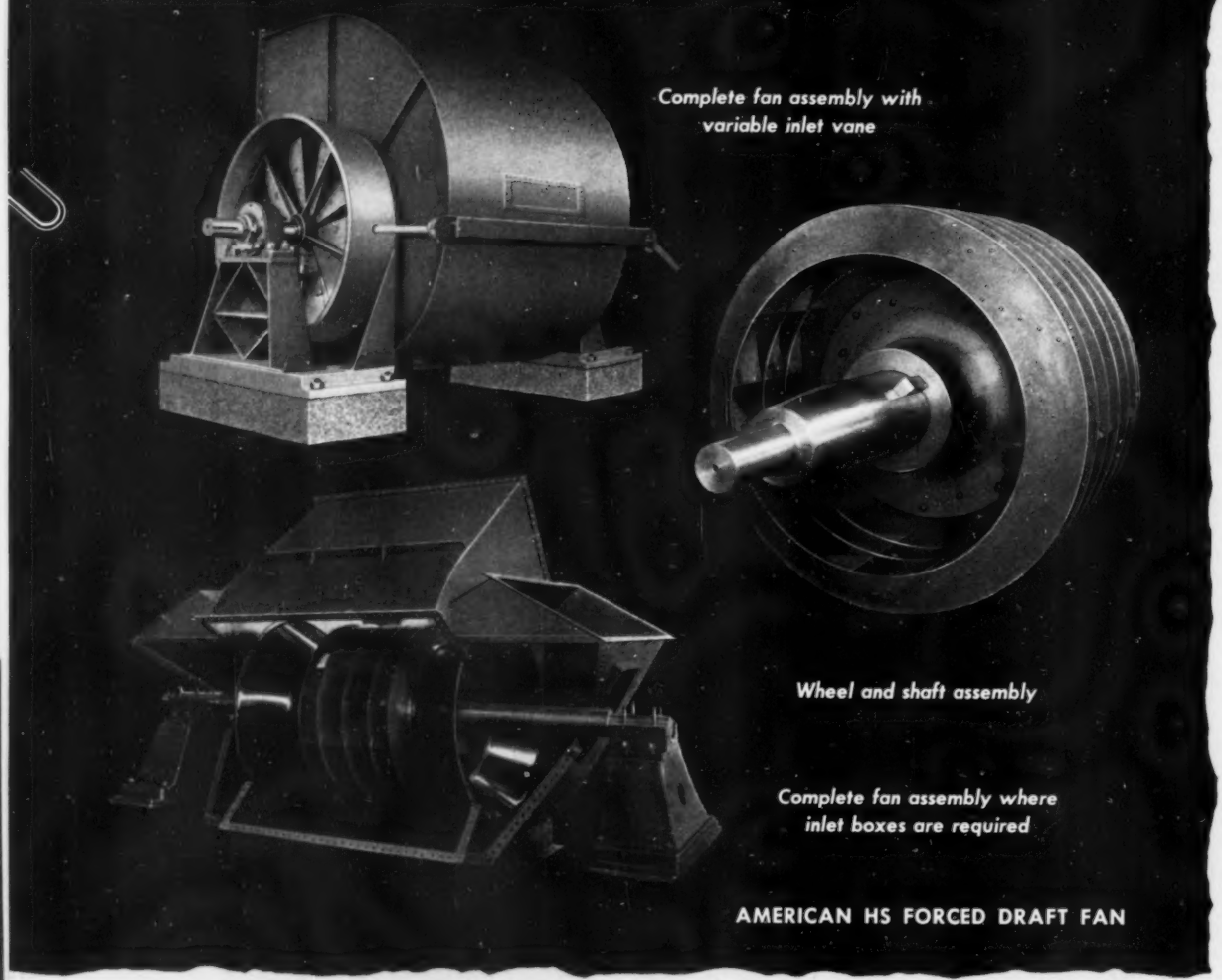
American Blower . . . a time-honored name in air handling



Complete fan assembly with variable inlet vane

Wheel and shaft assembly

Complete fan assembly where inlet boxes are required

AMERICAN HS FORCED DRAFT FAN

Memo to Power Plant Men —

You'll get high efficiency without entry loss and turbulence at a substantial power saving with non-overloading American Blower HS Fans for forced draft duty in your power plant.

AMERICAN BLOWER

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

Serving home and industry

AMERICAN-STANDARD · AMERICAN BLOWER · CHURCH SEATS & WALL TILE · DETROIT CONTROLS · KEWANEE BOILERS · ROSS EXCHANGERS

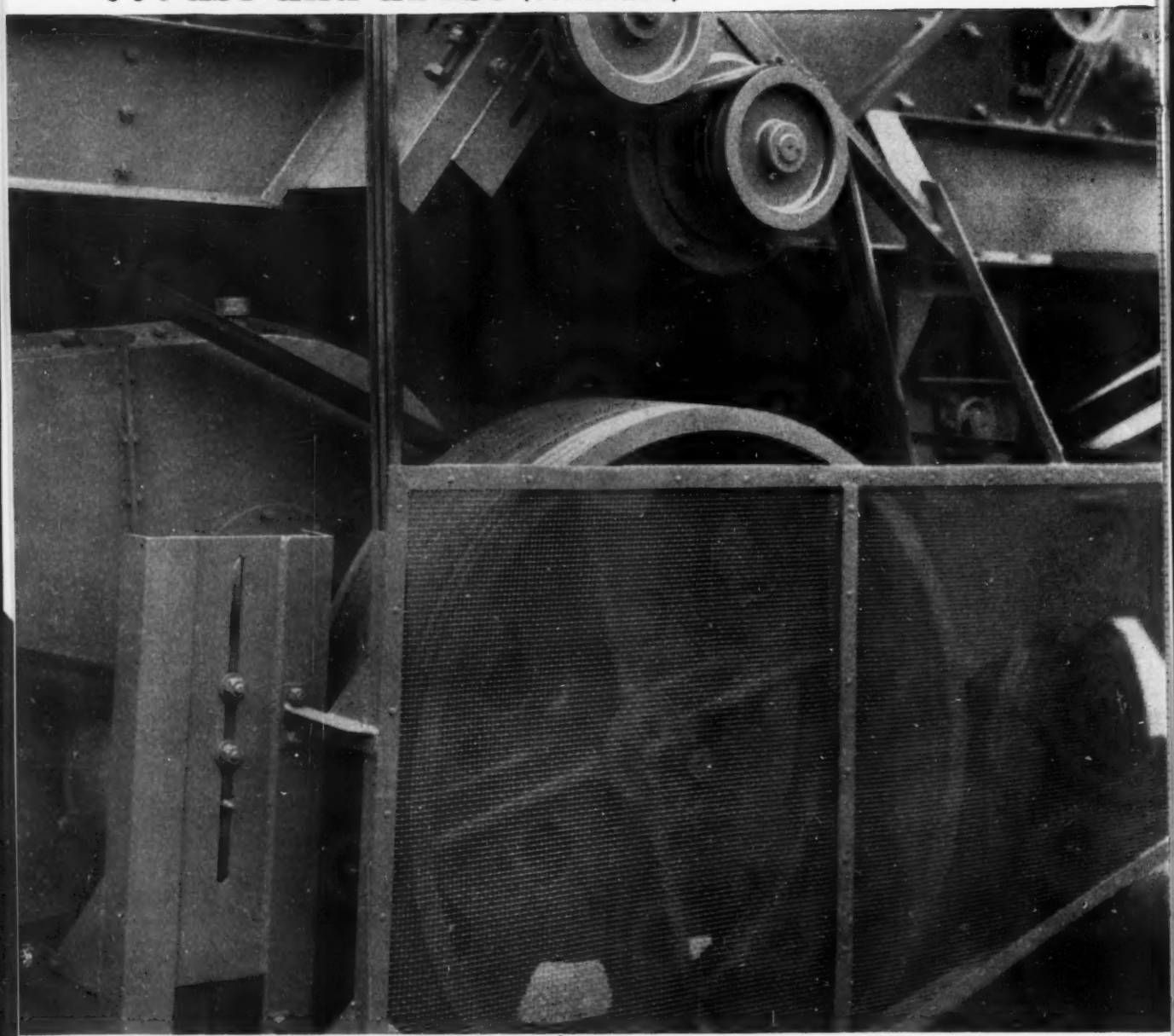
B. F. Goodrich Grommet belts at work

There's no soft diet in this gravel pit for the iron giant that gobbles and chews more than 2000 tons of tough rocks every day.

90 days of use and abuse

That big crushing unit swallows up to 300 tons of rocks every hour, carries them up a moving belt and dumps them into two crushers. But the jolting, jarring action is rough on the V belts used to keep the crusher crushing. Ordinary belts weren't lasting much more than 30 days. To find out how this problem of frequent and costly replacements was solved — see the following pages.

. . . use and abuse (continued)



Here are the tough rubber muscles that keep the giant-size rock-chewing jaws in motion hour after hour, day after day.

The problem described on the preceding page was solved when the equipment maker tried a set of B. F. Goodrich Grommet V belts. These belts *look* the same but because of an entirely different construction principle, Grommet V belts stand more shocks and heavier loads than any other kind. Instead of being ready for the junkpile after 30 days, the Grommet belts were still going strong after 90 days of use and abuse. Here's why:

Strongest V belt made

All the load-carrying cords in Grommet belts are concentrated in twin grommets. These grommets are cord loops made

like giant twisted cables except that they're endless. Since there are no center cords, the Grommet belt is more flexible, and so can "give" temporarily and absorb shock loads. As a result, Grommet belts last 20 to 50% longer, depending on the service. (The more severe the service, the greater the increase over ordinary belts.)

No weak spots

The section where cords overlap is the weak spot in ordinary belts. That's where 80% of V belt failures occur. But in Grommet V belts this cause of belt failure has been eliminated. The grommets are endless. There are no splices or overlaps—no weak spots to cause premature belt failure.

1/3 more gripping power

Grommet V belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip sheaves better. Size for size, Grommet belts give ⅓ more gripping power with less slip, pull heavier loads with a higher safety factor. And because there is less slip, there is also less surface wear.

Less stretch

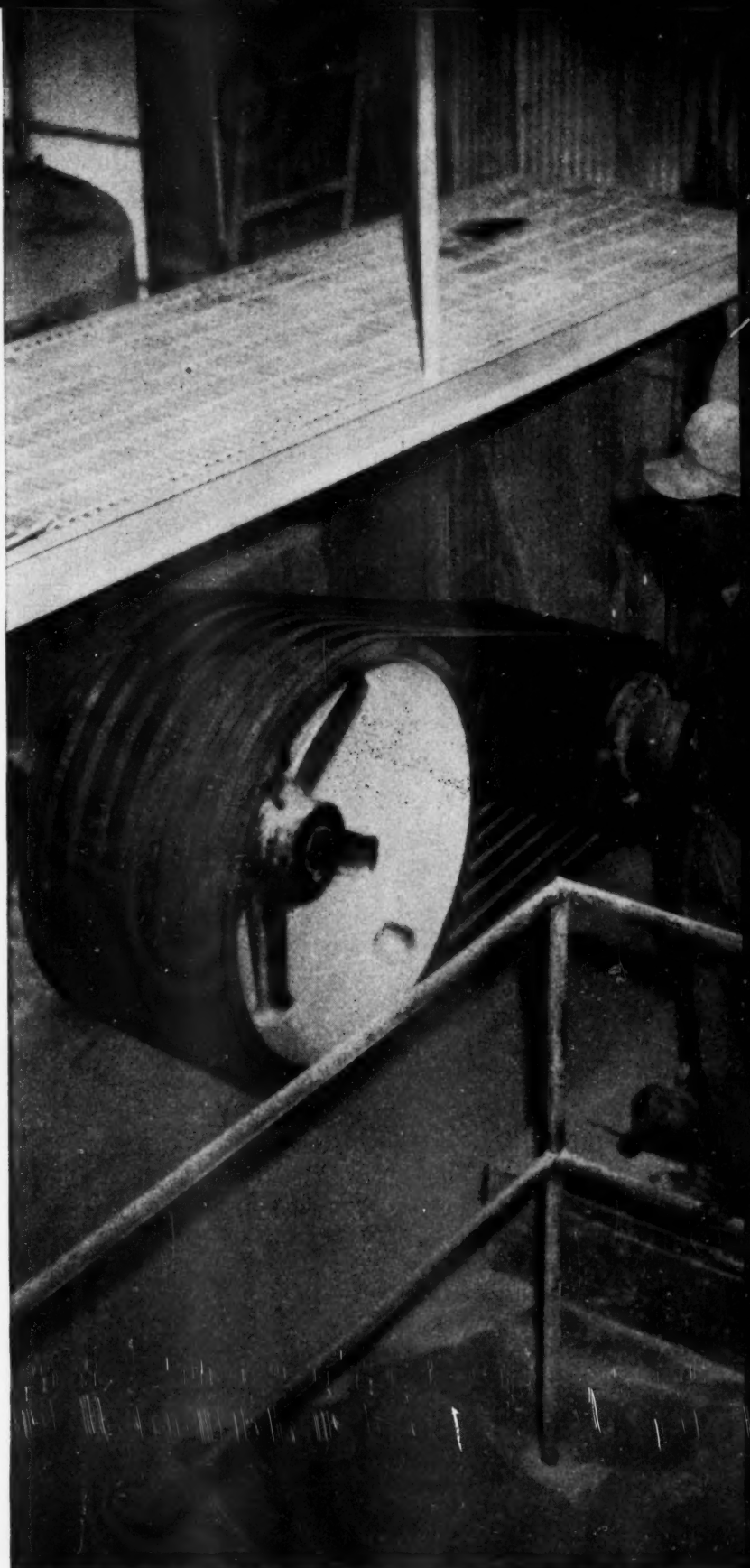
In ordinary belts under tension, the center cords loaf, the outer cords overwork because tension is greater near the driving faces. Grommet belts, with no center cords, have much more strength and less stretch. Grommet belts stretch, on an average, only about ⅓ as much as ordinary belts.

Save 3 ways

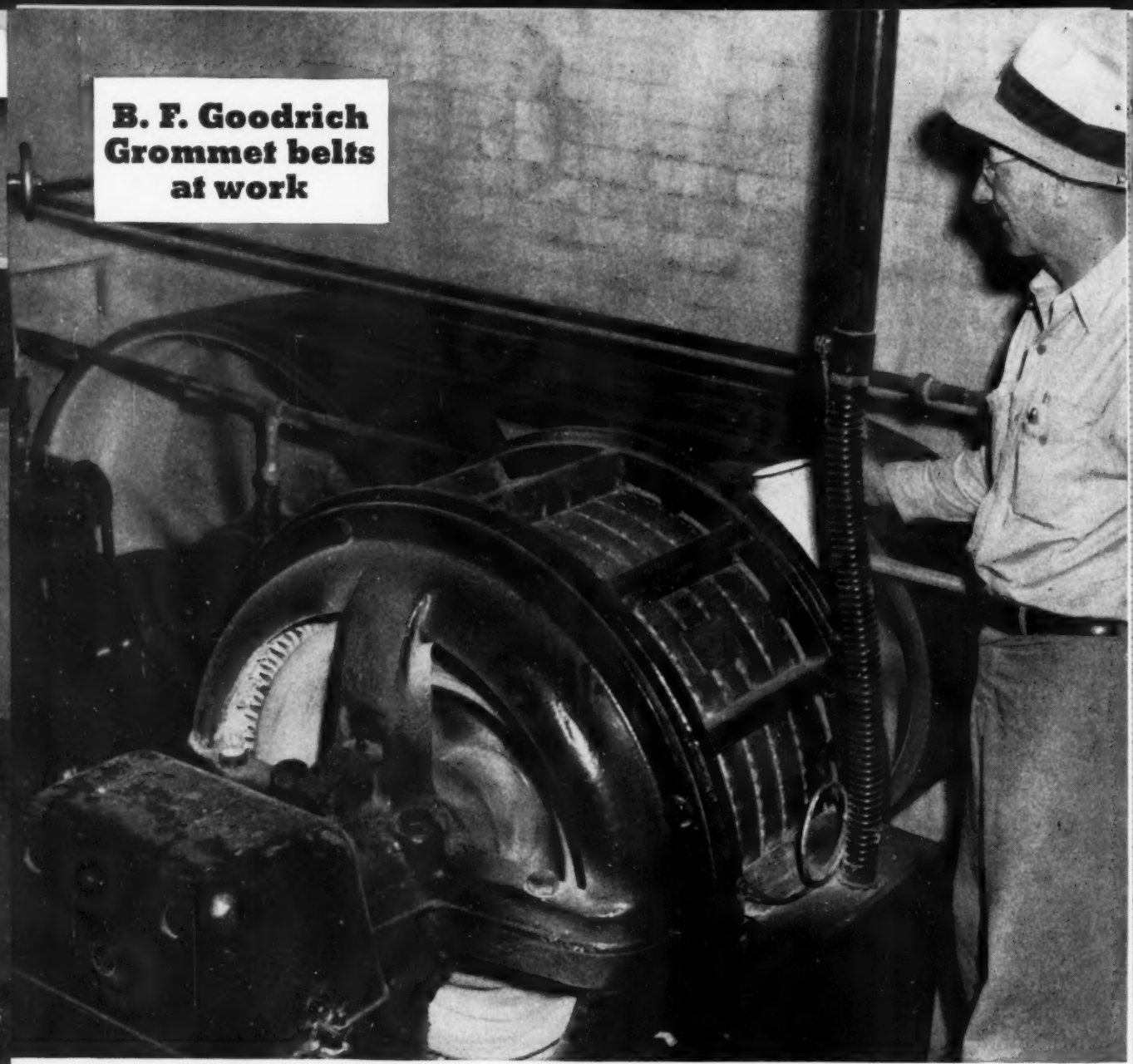
With Grommet belts, you save on replacement costs because they last 20 to 50% longer, on production costs because machines keep running with fewer interruptions, and on maintenance costs because V belts need less attention. Yet these savings they can make for you are all clear profit because they cost not one cent more than ordinary V belts. Only B. F. Goodrich makes the patented Grommet belt.

Where dust was cussed ➤➤

Crushing limestone to a fine powder for agricultural lime creates thick, white dust that looks like snow. This dust combined with the slightest bit of moisture makes the sheave surfaces slick, causes ordinary belts to slip, burn, soon wear out. To avoid this threat of frequent production delays, the Black White Limestone Co., Quincy, Illinois had BFG Grommet V belts installed in 1950. The belts are still on the job today, and there have been no costly plant shutdowns due to belt trouble.



Like the mills of the gods, this one grinds exceedingly small.



No vacations allowed for belts that keep this entire mill cool even during steaming hot Kansas summers.

6 years in cooler

Wichita's Kansas Milling Company makes a malted wheat flour that requires a cool plant. The cooling equipment—and belts which drive it—must perform around the clock, no time off.

B. F. Goodrich Grommet V belts were selected because other types of belts had required frequent maintenance involving shutdowns. It proved to be a perfect solution. The Grommet belts have operated constantly for six straight years. Maintenance? None! Downtime for repairs? None! Production savings? Plenty!

Grommet—T. M. The B. F. Goodrich Co.

The B. F. Goodrich Company
Dept. M-86, Akron 18, Ohio

☐ Send set of reports telling users' experiences and showing actual installations where Grommet belts outlasted all others.

☐ Please have a BFG distributor call. I'd like to find how I can save money with Grommet V belts.

Name_____

Firm Name_____

Address_____

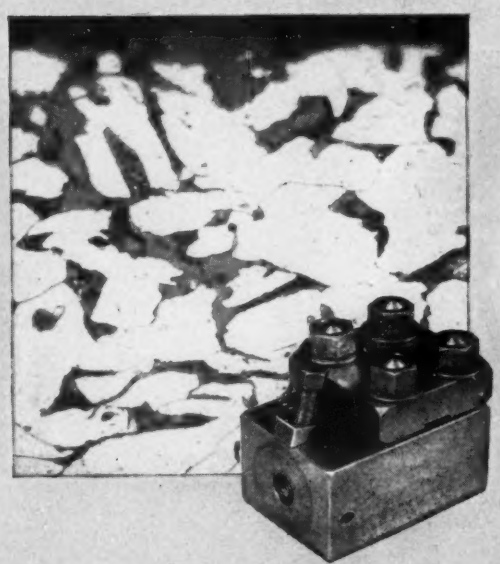
_____

B.F.Goodrich
INDUSTRIAL PRODUCTS DIVISION

Eliminate the Danger of

INTERCRYSTALLINE CORROSION

ALLIS-CHALMERS WATER CONDITIONING
Equipment — Chemicals — Service



Photomicrograph of edge of crack caused by intercrystalline corrosion. U. S. Bureau of Mines detection unit (inset) tests for causes of intercrystalline corrosion.

Dangerous and costly cracks due to intercrystalline corrosion (embrittlement) will be no problem in your boilers if you have given careful consideration to the problem *in advance*. You can get the information you need to analyze your operations from Allis-Chalmers water conditioning Bulletin 45. It explains intercrystalline corrosion — the cause of embrittlement. It tells what tests are necessary to recognize this condition. And it discusses what you can do.

Get the Answer to Many Problems

Bulletin 45 is one of a series of Allis-Chalmers bulletins on water conditioning problems. Like all of these useful bulletins, it is based on the wide experience of Allis-Chalmers water conditioning men in handling water problems for nearly every industry. In addition, it is based on Allis-Chalmers long experience building turbines and power plant equipment.

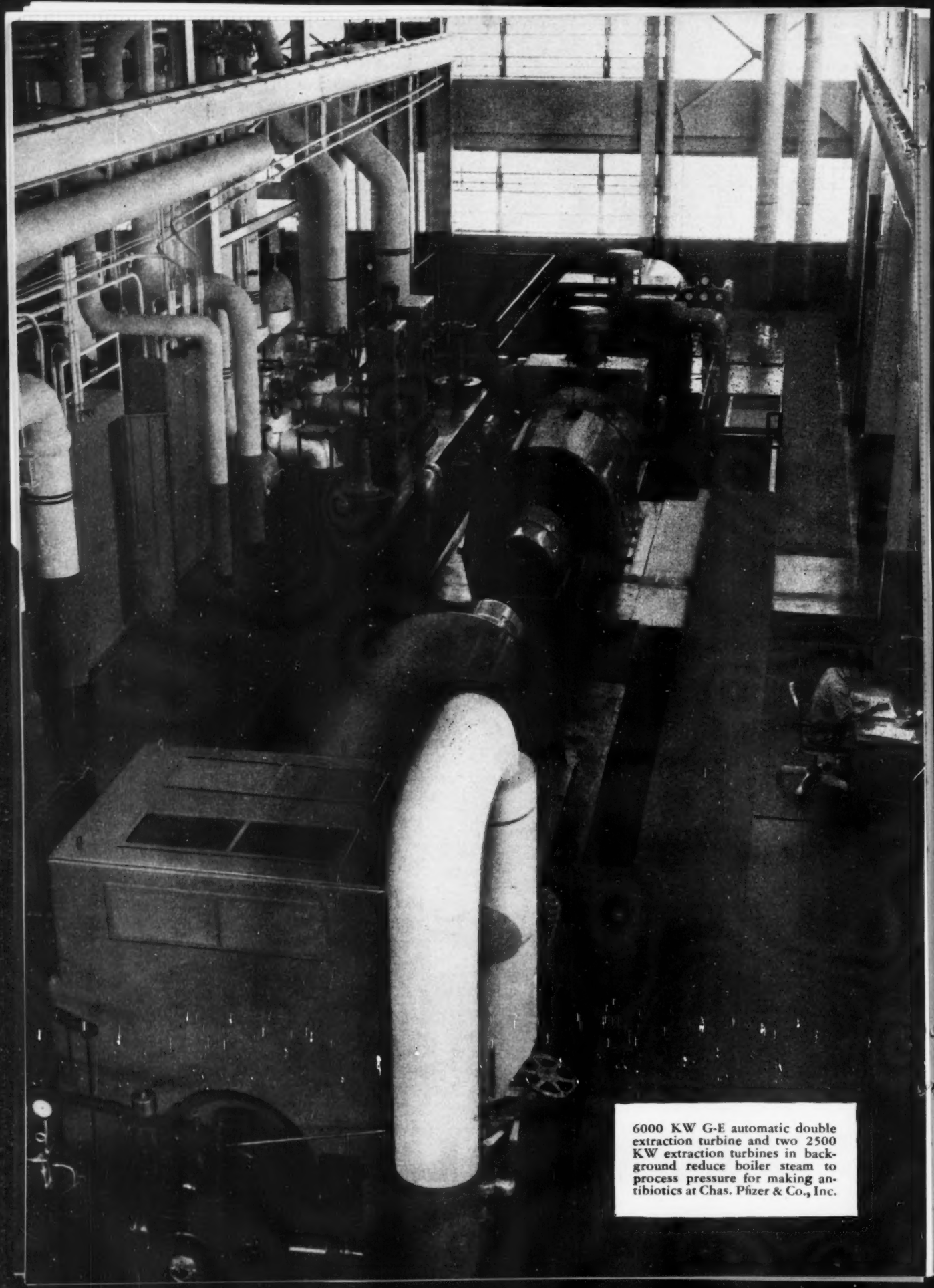
Complete Service Available

Allis-Chalmers gives you complete water conditioning service. You can get analyses and reports on your problems. You can get the chemicals needed in all water treatments. And you can get the equipment for any system.

A-4014

For your copy of Bulletin 45 on intercrystalline corrosion, write Allis-Chalmers, Milwaukee 1, Wisconsin. Or better, call your nearby Allis-Chalmers district office and have an Allis-Chalmers representative consult with you on your water problems.

ALLIS-CHALMERS



6000 KW G-E automatic double extraction turbine and two 2500 KW extraction turbines in background reduce boiler steam to process pressure for making antibiotics at Chas. Pfizer & Co., Inc.

G-E Extraction Turbine at Chas. Pfizer & Co., Inc. Increases Plant Thermal Efficiency Over 15%

Extraction pressures held constant, even under varying loads; turbines reduce boiler steam to process pressures for use in making antibiotics

Plant thermal efficiency was increased over 15% when Chas. Pfizer & Co., Inc., producer of antibiotics, recently installed the third General Electric automatic extraction turbine-generator at its Groton, Connecticut, plant. A 6000 KW extraction unit was installed to take fullest advantage of available high-pressure steam, and to obtain additional economical by-product power.

PRESSURE HELD CONSTANT

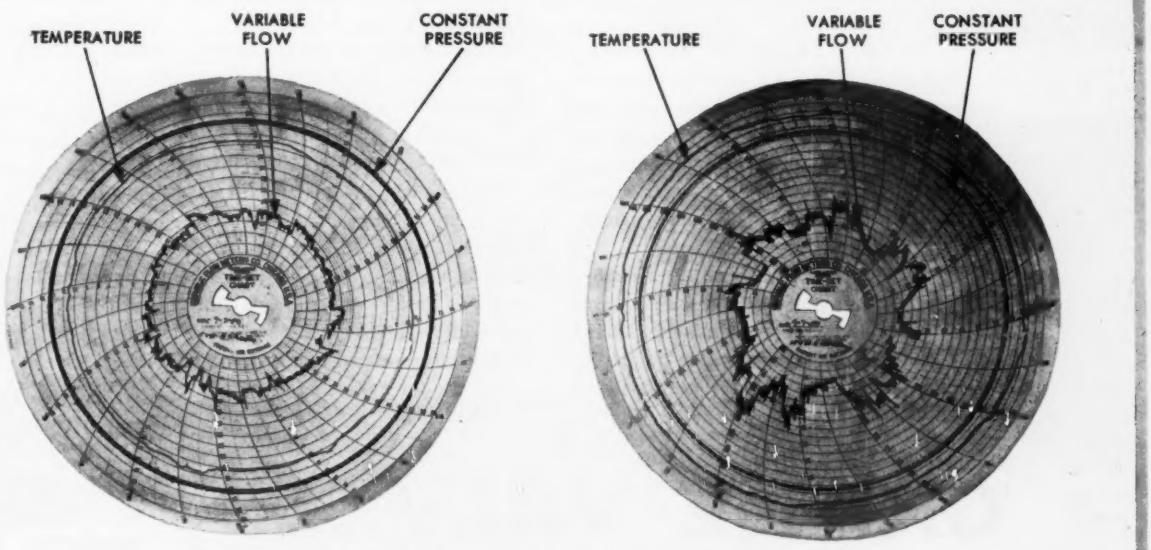
The double automatic extraction turbine takes steam at 725 F, 600 psig, and extracts at 135 and at 50 psig for plant process uses in the making of terramycin and other antibiotics. Chas. Pfizer & Co., Inc. reports that accurate turbine governing holds electrical frequency constant, and keeps extraction pressures precise, even when the quantity of extracted steam varies. (See charts below.)

If your plant uses process steam, why not take advantage of G.E.'s experienced turbine engineering resources. G-E engineers will study and recommend ways for you to best utilize steam supply. Get more for your turbine dollar with G-E turbine-generators. General Electric Company, Schenectady 5, New York. 256-8

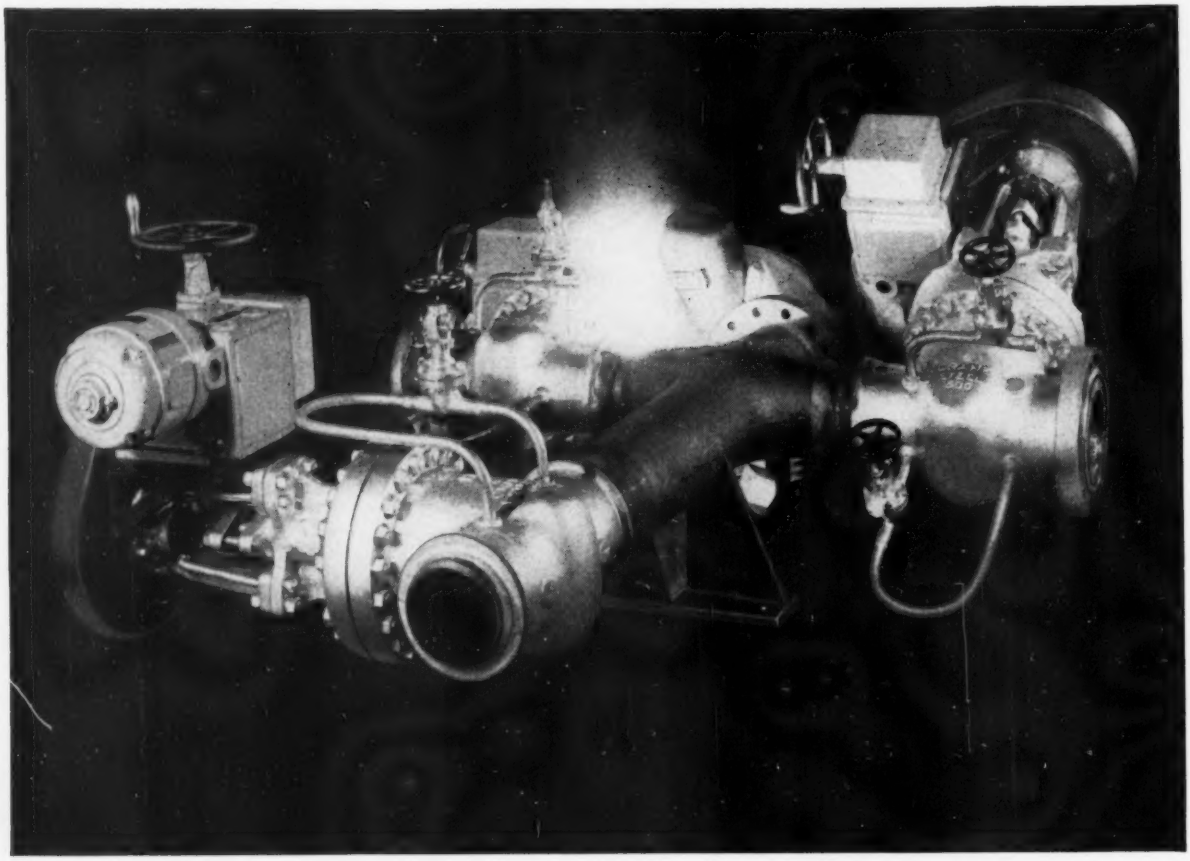
1878 75 1953 YEARS OF ELECTRICAL PROGRESS

You can put your confidence in—

GENERAL ELECTRIC



Even when the quantity of extracted steam varies over wide limits, extraction pressure remains constant, as indicated on the charts above. These charts show typical performance of a General Electric double automatic extraction turbine such as the one installed at Chas. Pfizer & Co., Inc.



What's CRANE cooking up here?

Big Piping Savings for You—

The man behind the mask above is a *unit fabrication* specialist with a talent for saving you time, trouble—and dollars—in the long run.

He's part of a crew of experienced mechanics in one of the big Crane Fabricating Shops, where piping units like this 8-inch assembly are built *precisely* to specification.

And it's a complete as well as a quality service, for Crane takes over at the blueprint stage; supplies all valves and component parts—makes the pipe bends—does the welding. Right at hand are the best facilities for heat-treating or stress-relieving, radiography, etc., to assure uniform strength and dependability. The finished unit is pre-tested and proved in advance, ready for quick installation in your piping system.

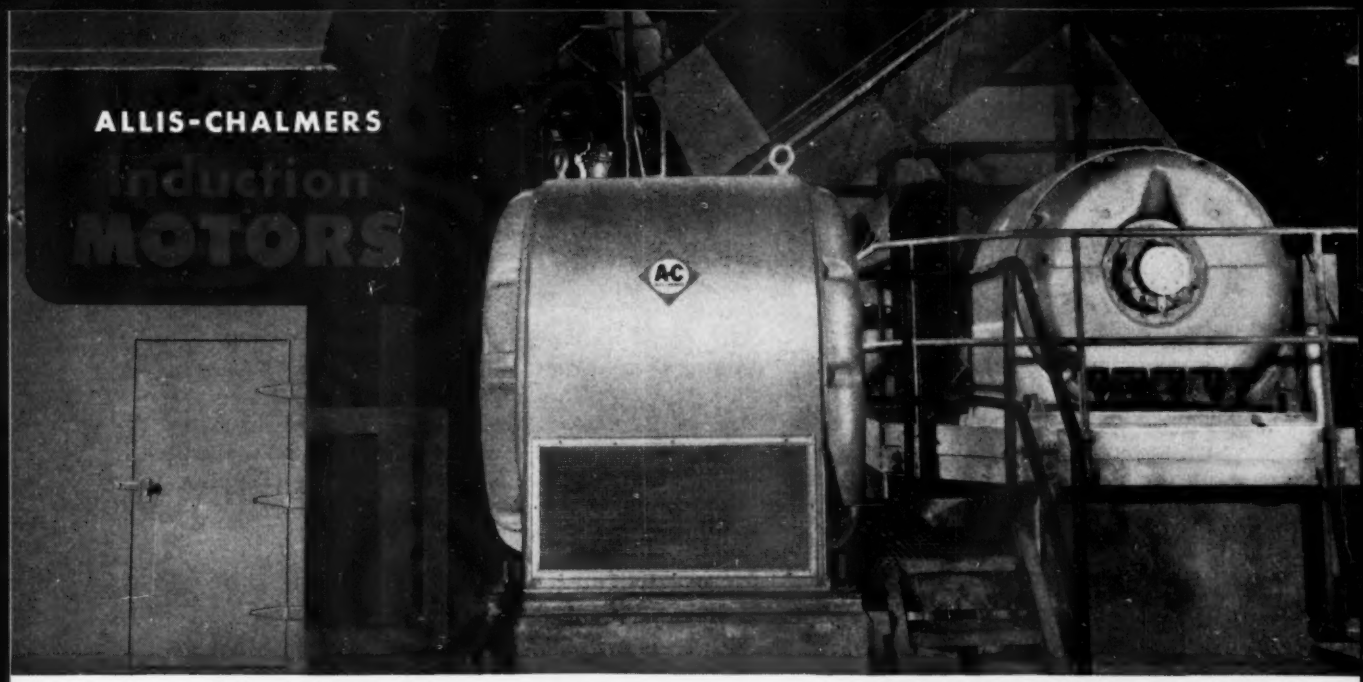
You take no risk—you pay for no spoilages, and your erection crew is spared many a major headache. But, why not let your Crane Representative review your piping layout and help you decide where Crane Unit Fabrication will be to your advantage? There's also further information in your Crane 53 Catalog —or write for Folder AD-1771.

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois

Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING



Left to right (above) are drip-proof, silicone insulated, 1000-hp, forced and induced-draft fan motors for unit No. 2. Forced draft fan motors for unit No. 3 will be of the weather-protected type for installation outdoors.

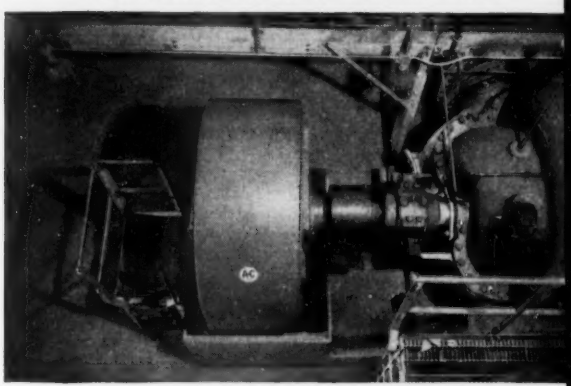
LET'S TAKE A LOOK AT TANNERS CREEK

One thing you're sure to notice at the Tanners Creek plant is that all the major auxiliaries for generating unit No. 2 are driven by Allis-Chalmers motors. Pictured here are a few of the larger ratings in this modern power plant of Indiana & Michigan Electric Company, a part of the American Gas and Electric system.

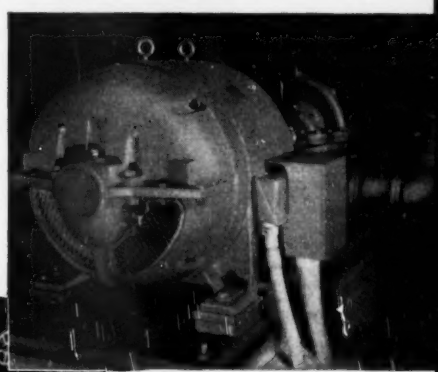
It's worthy of note that A-C is also building the motors for generating unit No. 3, scheduled for operation in 1954.

Allis-Chalmers builds a complete line of integral horsepower motors for power plant service, and your A-C representative can help you select the motors you need.

A-4084



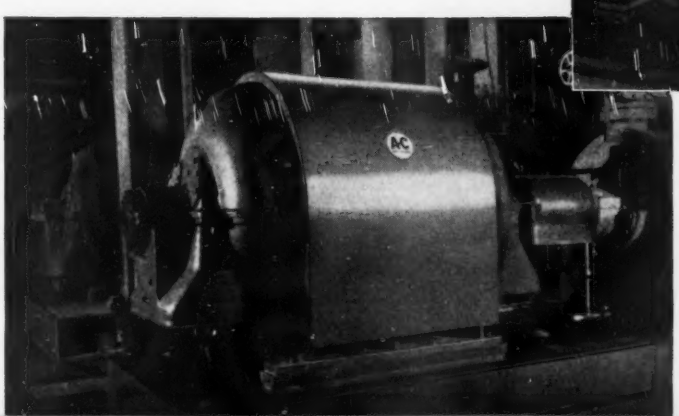
One of two 300-hp, 2300-volt, 218-rpm, drip-proof squirrel-cage motors driving circulating water pumps.



Rated 200 hp, 2300 volts, 1760 rpm, this drip-proof squirrel-cage motor driving an Allis-Chalmers screen wash pump is typical of the smaller ratings.

ALLIS-CHALMERS

Milwaukee 1, Wisconsin

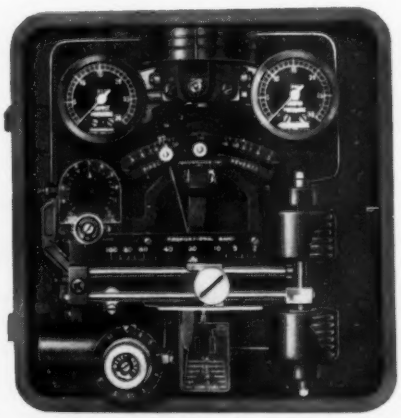


These dependable boiler-feed pump motors are rated 2000 hp, 2300 volts, 3580 rpm each.

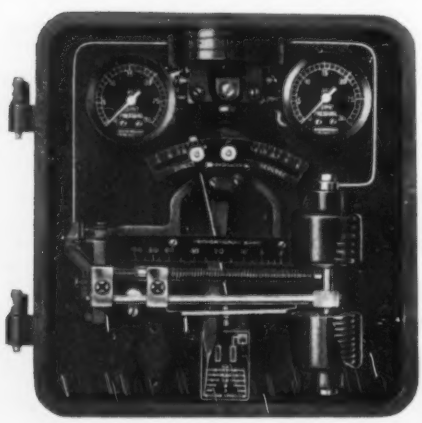
6 Reasons

Wide range of selection of the basic controller unit to fit your application is represented by the five single-unit controllers illustrated below . . . five of the many reasons why Masoneilan Liquid Level Controllers offer you more for your money. The sixth is the convenience of grouping any two of these in one case as illustrated in the model to the right. This range of selection enables you to obtain from *one* manufacturer the control equipment for almost any liquid level application.

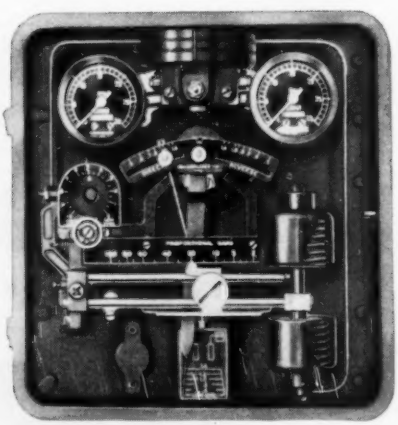
Model 12800 — The basic proportional controller; may also be used as a transmitter; may be converted in the field to a differential gap controller.



Model 12810 — Adds reset action to the proportional controller. Conversion of Model 12800 may be accomplished in the field if desired.



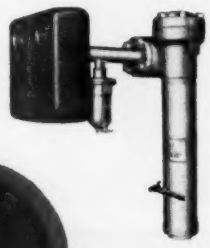
Model 12820 — The pneumatic transmitter provides an output air signal which is proportional to level changes, for indication, recording or control.

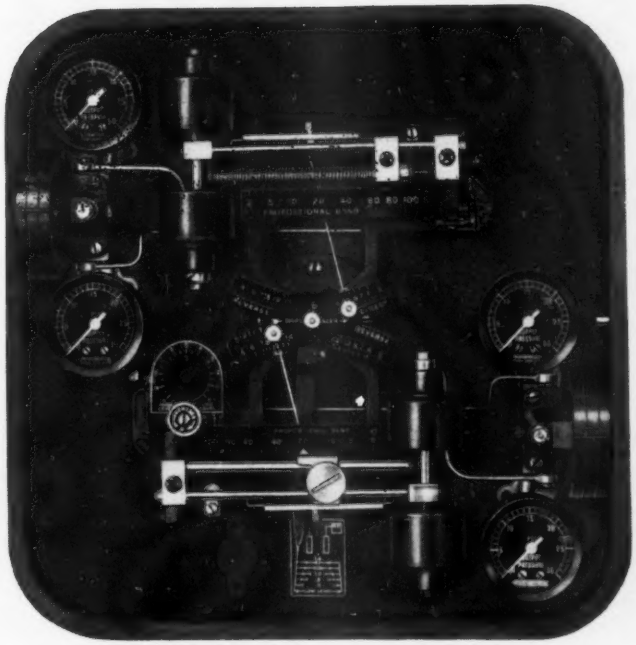


Model 12830 — The differential gap controller. May be converted to a proportional controller in the field if process changes require it.

TWENTY POSSIBLE

Why You Should Select Masoneilan Level Controllers





Model 12800-20 — A duplex model grouping the proportional controller and pneumatic transmitter. Any combination of two identical or dissimilar single units is possible — a total of fifteen combinations.

Model 12840 — The pneumatic set controller provides for remote adjustment of set point. Available with either proportional or proportional-reset action.

Simplicity of design; sensitive accuracy of control; wide choice of materials; ease of maintenance; convenience of installation; and sturdy, long lasting construction are six *other* reasons why you should select Masoneilan 12000 Series Liquid Level Controllers.

ALL HIGH Quality Coefficient PRODUCTS

MASON-NEILAN

REGULATOR CO.

1186 ADAMS STREET, BOSTON 24, MASS.

Sales Offices or Distributors in the Following Cities: New York • Syracuse • Chicago St. Louis • Tulsa • Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati Detroit • San Francisco • Boise • Louisville • Salt Lake City • El Paso • Albuquerque Charlotte • Los Angeles • Corpus Christi • Denver • Appleton • Birmingham • New Orleans Dallas • Seattle • Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

INSTRUMENT COMBINATIONS

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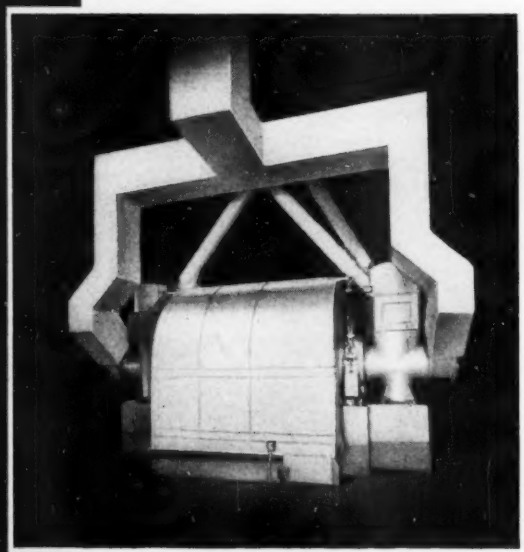
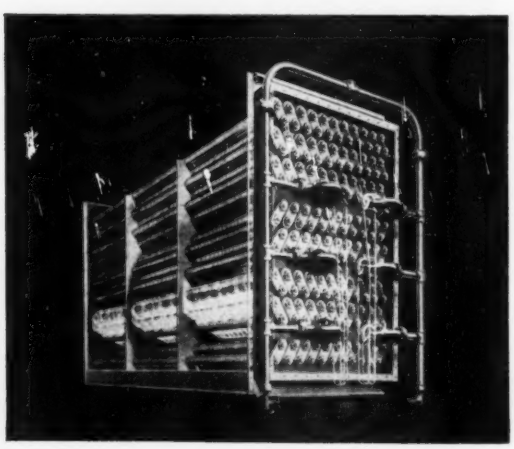
STEAM GENERATORS for every central station or industrial use, designed, engineered and built to meet your needs for the economies of higher temperatures and pressures over control ranges not previously obtainable.

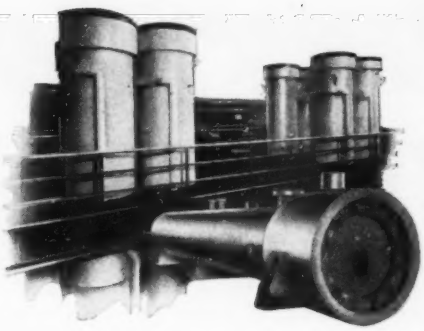


BALL MILL PULVERIZERS which grind hard, abrasive fuels to a constant fineness. Operating records show low maintenance, high availability of 99% or better.

SUPERHEATERS of the convection and radiant type, either singly or in combination. Superheat control over a wide load range is also offered as a means of positive and accurate control of final temperature.

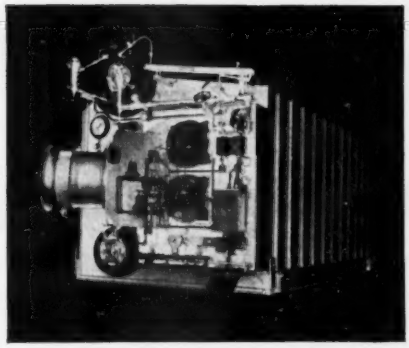
ECONOMIZERS of the cast-iron, extended-surface steel-tube type which are corrosion-resistant, impervious to soot fires, easily cleaned, and of unique, simple design. Bare tube construction also available.





PACKAGE STEAM GENERATORS in capacities of 10,000 to 30,000 lb. of steam per hr. Water-tube type, plant assembled, shipped ready to install. Design pressures of 250, 525, 825 psig provide operating pressures from 100 to 800 psig.

FEEDWATER HEATERS of the shell-and-tube type, as well as direct contact arrangements, are available. "Lockhead" closures have been built for pressures up to 3500 psi.

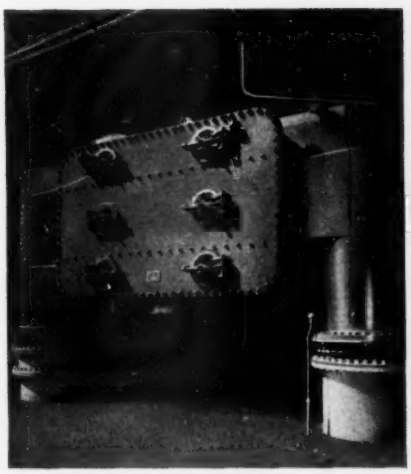


many of your steam plant needs

Only Foster Wheeler offers such a broad line of steam plant equipment engineered for increased efficiency through modernization

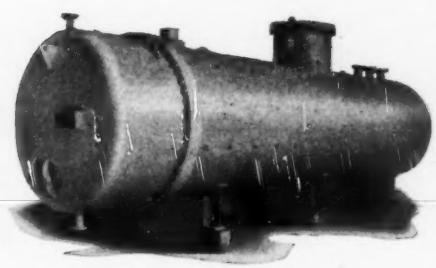
IN OVER 50 YEARS of service to the power industry, Foster Wheeler has pioneered the development of steam generators, fuel systems, condensers and cooling systems of the highest efficiency. Continuous research and engineering have created a background of technical experience, *as well as* an integrated line of equipment in which each individual product is designed to contribute to the efficiency of all.

FOSTER WHEELER CORPORATION
165 Broadway, New York 6, N. Y.



CONDENSERS to meet any conditions of headroom at any location. Our shops are fully equipped to supply units of 100,000 sq. ft. and larger.

EVAPORATORS for boiler feed make-up and of heat-transformer types in all sizes. Special types to handle raw and treated make-up to give the best thermal and descaling operation as well as producing pure vapor.



COOLING TOWERS custom-engineered to meet your requirements for greatest economy. Mechanical draft, counter-flow type. Provide minimum spray loss, flexibility to meet all weather conditions.

FOSTER WHEELER

for PRODUCTION efficiency of your POWER SUPPLY

When building or remodeling a plant, careful thought is given to plant layout so that the ultimate can be achieved in both efficiency and production. Production flow charts, showing the proper materials handling procedures and fabrication processes and their efficient power supply are all considered in blueprint planning.

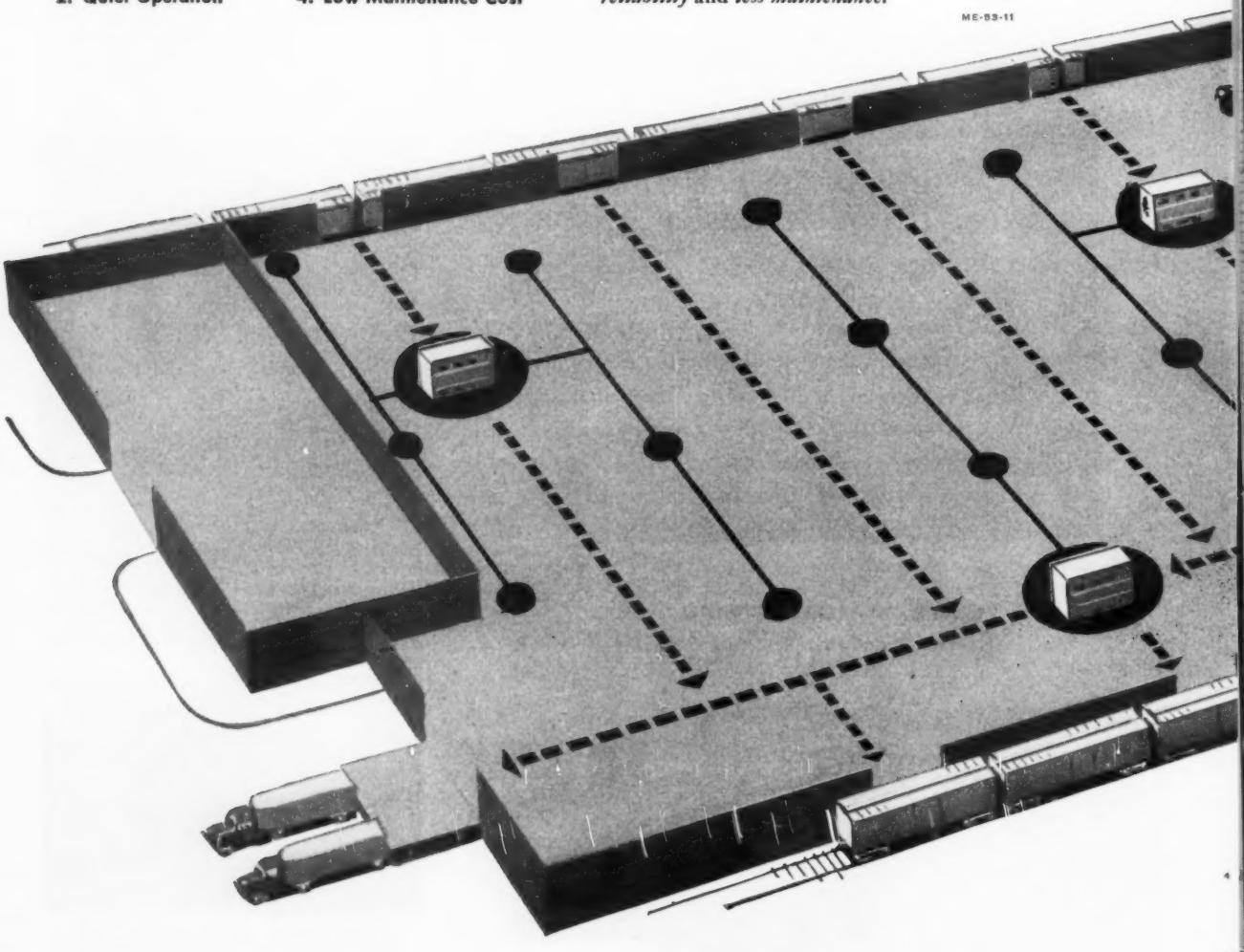
Such consideration would reveal the following features of prime importance for power supply

1. Location Flexibility
2. Quiet Operation
3. Efficient Operation
4. Low Maintenance Cost

Moloney Dry-Type Transformers will provide these features assuring you of an uninterrupted power flow under all operating conditions. Moloney Transformers also help to maintain higher levels of production efficiency for workers because of their quiet operation.

It would be wise to consider all these facts when selecting the Dry-Type Transformer to supply your power needs. If you do this, your choice will probably be Moloney . . . the transformer that gives *better performance* with *greater reliability* and *less maintenance.*

ME-53-11



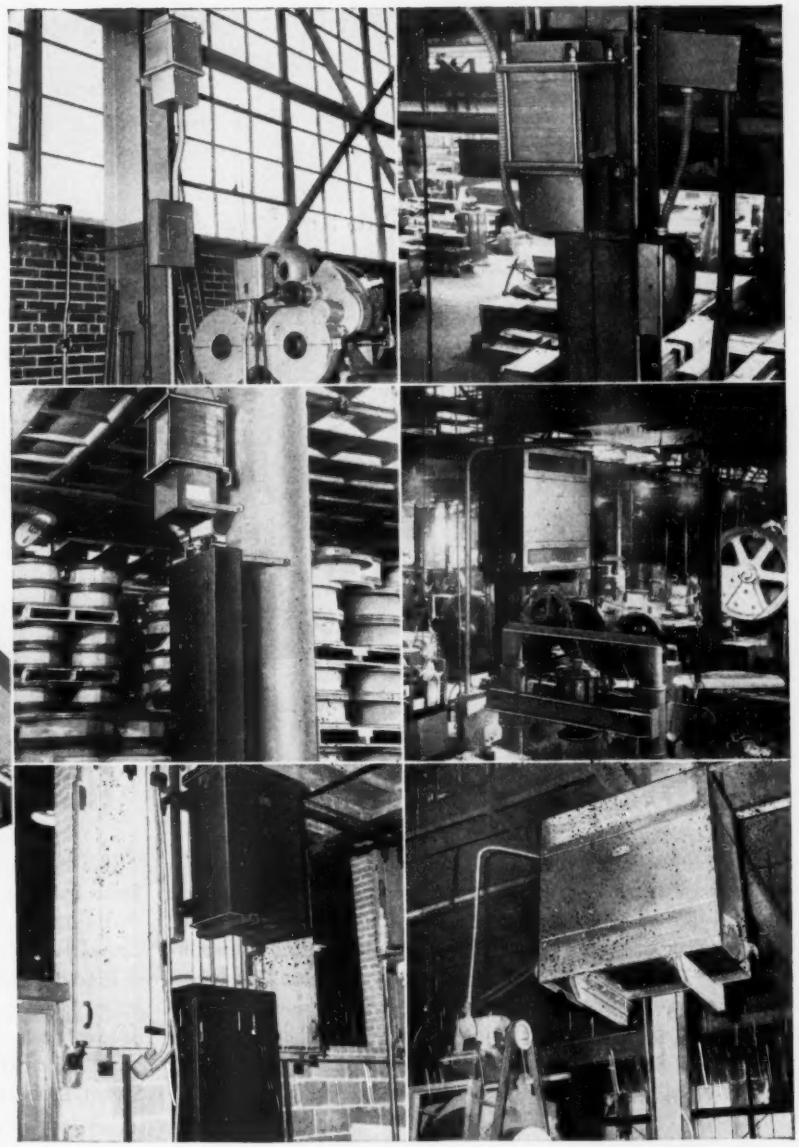
MOLONEY ELECTRIC

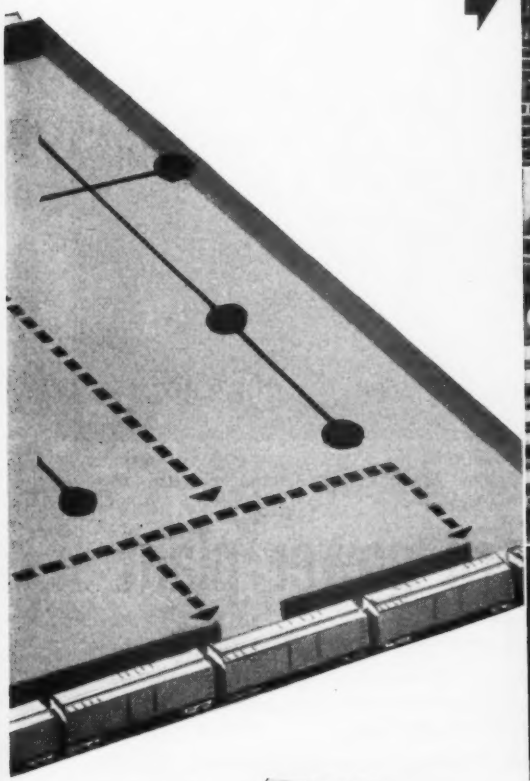
Manufacturers of Power Transformers • Distribution Transformers • Load Ratio Control Transformers

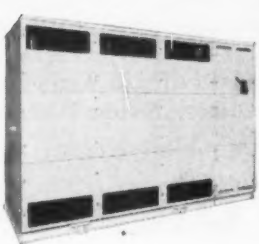
SALES OFFICES IN ALL PRINCIPAL CITIES • FACTORIES AT ST. LOUIS

EFFICIENCY check the ... Specify MOLONEY!

Typical installations showing how Moloney Dry-Type Transformers are readily located at the most convenient point along the production line.







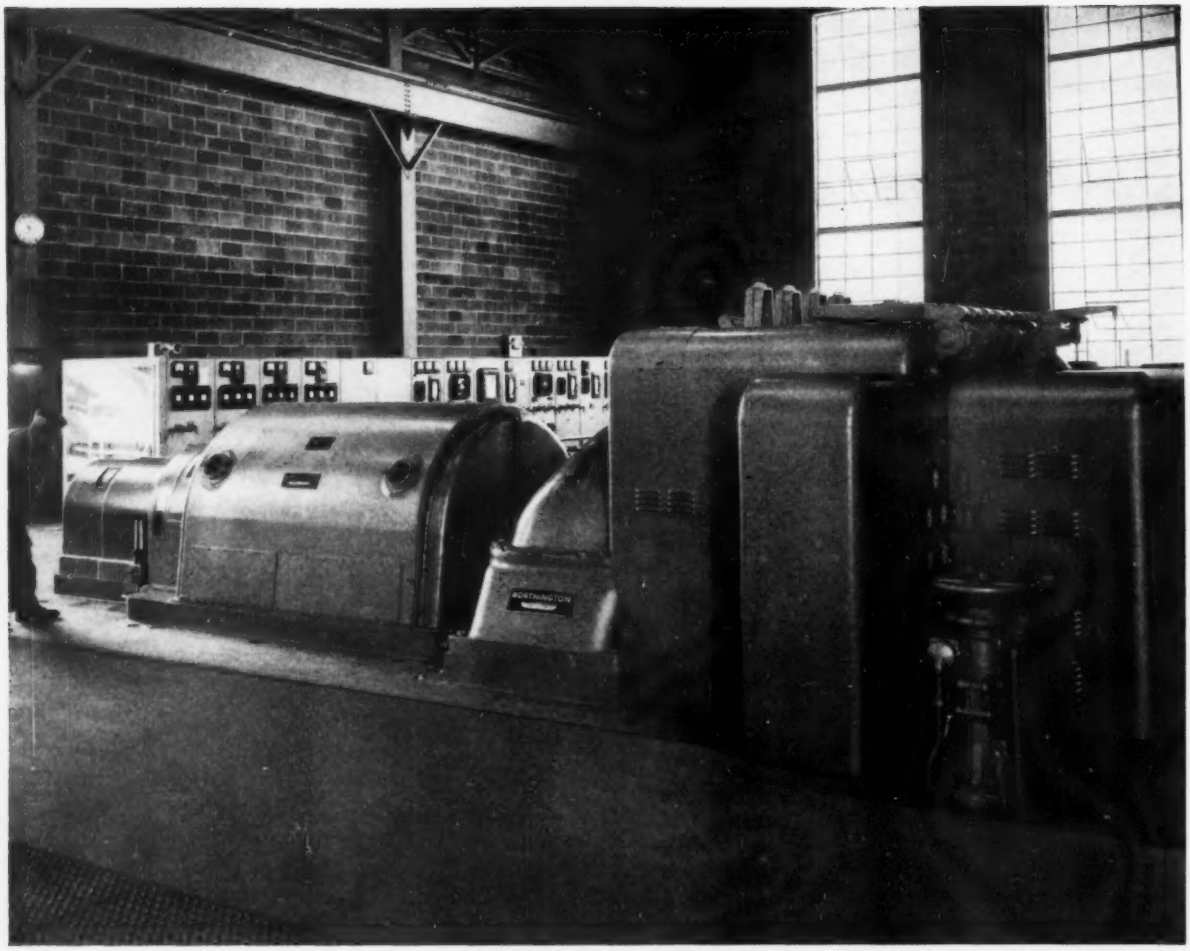
Moloney Dry-Type, Air-Cooled Transformer. Primary voltages range up to 15,000 volts, and sizes to approximately 3,750 Kva. Class B insulation (80° C. rise) is used.

C O M P A N Y

Step Voltage Regulators • Unit Substations

MISSOURI AND TORONTO, ONT., CANADA

MOLONEY ELECTRIC = { BETTER PERFORMANCE / GREATER RELIABILITY / LESS MAINTENANCE



STREAMLINED WORTHINGTON TURBINE at Iowa State has provision for steam extraction for heating, laboratory, and process purposes throughout the college.

Iowa State completes modern power plant

With the installation of a streamlined Worthington turbine-generator, Iowa State College, in Ames, Iowa, has completed the modernization of its power plant. The use of heavy gauge lagging covers with rounded corners is responsible for the good looks of the modern Worthington unit.

Rated at 3000 kw, the Worthington turbine-generator is of the condensing-extracting type and operates on steam at 240 psi. The unit is designed for conversion to 400 psi, in case the college decides to go to the higher pressure.

By installing a Worthington turbine-generator, Iowa State benefited by the undivided responsibility that goes with turbine-generators designed, assembled and tested as complete units *before* shipment.

Find out how Worthington turbine-generators pay off in longer, more economical service. Sizes up to 11,500 kw. Get in touch with your nearest Worthington district office for more information. Or write to Worthington Corporation, Steam Turbine Division, Section T.3.2, Wellsville, N. Y.

T.3.2

WORTHINGTON

A GREAT TEAM IN STEAM

Single-Stage Turbines • Multi-Stage Turbines • Turbine-Generator Sets • Feed Water Heaters • Boiler Feed Pumps • Surface Condensers

Remember the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

Available in all piping materials!

ALLOY OR NON-FERROUS PIPING is often the answer to problems of contamination, corrosive action, severe pressures and temperatures, or cyclic operation. You can obtain TUBE-TURN Welding Fittings and Flanges of stainless steels, nickel and nickel-base alloys, copper and copper-base alloys, aluminum and aluminum-base alloys, and newest of all, titanium. For good service in welding fittings, in carbon steels, or in alloy or non-ferrous metals, call your nearby TUBE TURNS' Distributor. He's ready to serve you from industry's most complete line.

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles • Denver • Atlanta • Dallas • Midland, Texas

Subsidiaries: TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO • PENNSYLVANIA FORGE CORPORATION, PHILADELPHIA, PA.

ENGINEERING SERVICE

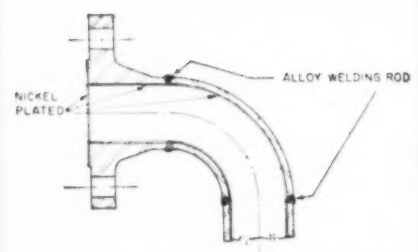
TUBE TURNS' *Engineering Service*

can help you cut cost of corrosion-resistant piping

G. A. GAUM is one of TUBE TURNS' Engineering Service Division men spending a great deal of time in the field obtaining performance data that contributes to improved piping technology.

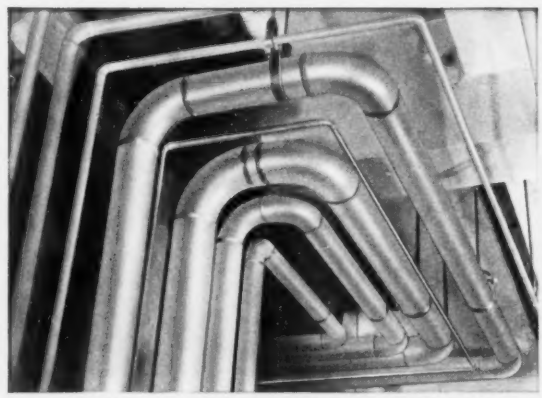
THE COST of corrosion-resistant piping can often be minimized by the use of standard carbon steel piping *plated* on the inner surface with such materials as nickel, copper, etc. In atomic energy plants, nickel-plated piping in sizes through 42" is giving satisfactory service, and has substantially reduced original cost. The method is also applicable to many industrial processes where corrosion resistant materials are specified.

Such plating is generally .008" thick, and can be applied in heavier thicknesses where desirable. You can obtain recommendations on preferred plating sources, proper welding techniques and rods from TUBE TURNS' Engineering Service—always ready to help you with special piping problems.



NICKEL PLATED INSTALLATION PROCEDURE

Installation procedure for nickel plated welding fittings and flanges.



These welded aluminum lines, fabricated with TUBE-TURN Welding Fittings, are permanently leakproof, reducing maintenance to a minimum. Since Tube Turns, Inc. offers the world's broadest line of welding fittings and flanges, all necessary types of welding fittings for any job can be obtained from one reliable source.

Dimensional accuracy of TUBE-TURN Welding Fittings speeds fabrication in the shop or in the field. True circularity and uniform wall thickness assure perfect alignment. Each TUBE-TURN welding fitting is individually examined by skilled inspectors for accuracy.

TUBE TURNS, INC., Dept. C-9
224 East Broadway, Louisville 1, Kentucky

Please send me free copy of:

- ☐ Special Alloys
- ☐ Pipe and Fitting Materials
- ☐ Stainless Steel Welding Fittings and Flanges
- ☐ Design Properties of Pipe

Your Name _____

Address _____

City _____ *State* _____

Position _____ *Company* _____

DISTRICT OFFICES

New York	Tulsa
Philadelphia	San Francisco
Pittsburgh	Los Angeles
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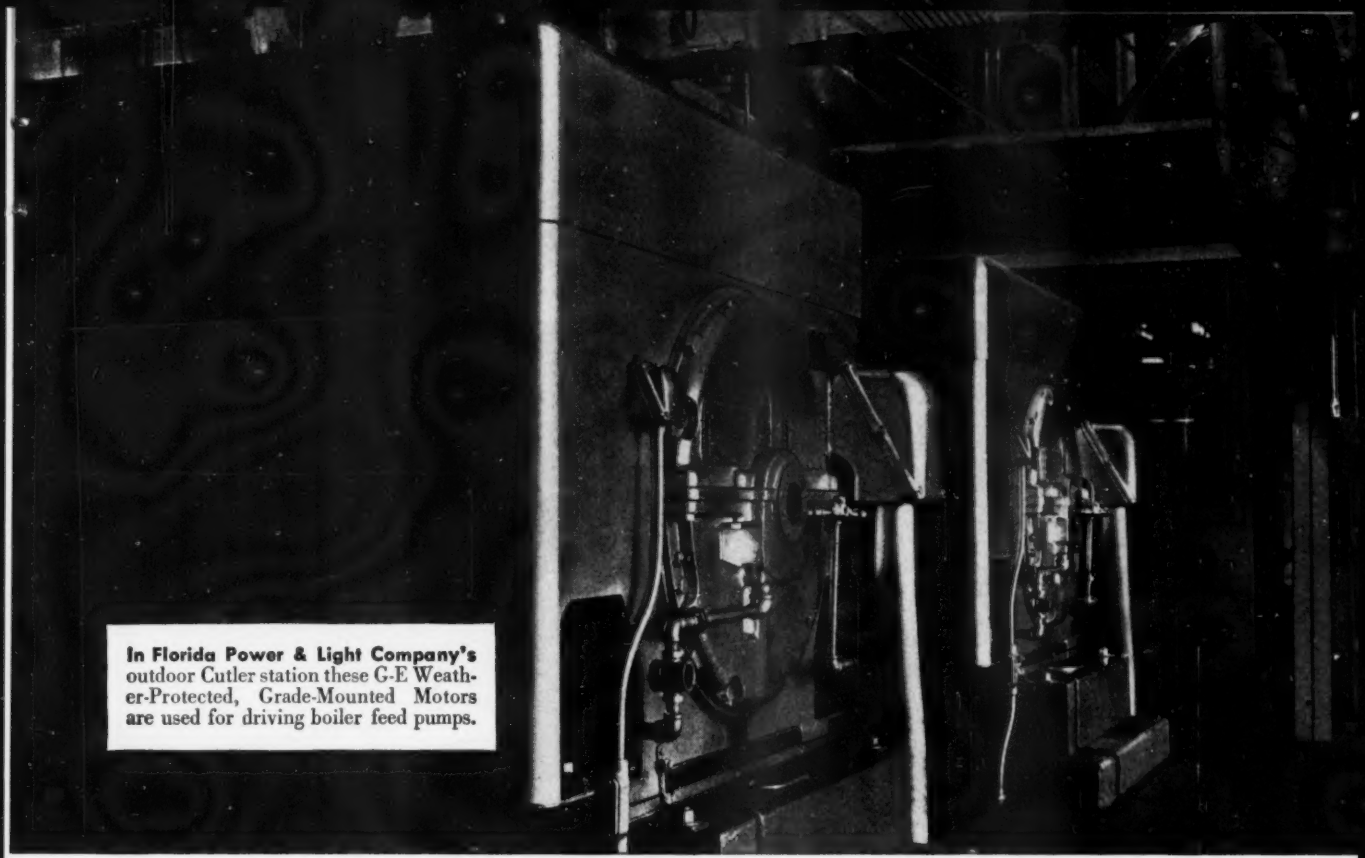
"tt" and "TUBE-TURN" Reg. U. S. Pat. Off.

TUBE TURNS, INC.

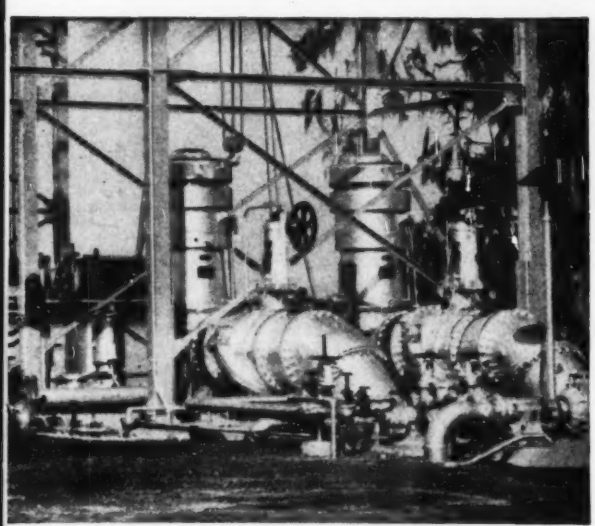
LOUISVILLE 1, KENTUCKY



In Florida Power & Light Company's outdoor Cutler station these G-E Weather-Protected, Grade-Mounted Motors are used for driving boiler feed pumps.

Designed specifically for outdoor, all-weather applications . . .

G-E Weather-protected Motors Provide Vital Continuous Service



G-E Weather-Protected Vertical Motors coupled to circulating water pumps operate outdoors in all weather at Florida Power & Light Company's Palatka Station.

Here's a low cost motor that the weather can't stop. For vital outdoor power station service, you can always count on reliable performance from rugged G-E Weather-Protected Motors . . . in all kinds of weather. An extremely effective ventilating system minimizes entrance of rain, snow, sleet and other airborne particles. Windings and other internal parts stay dry . . . assure you of dependable, all-weather service at minimum installed cost.

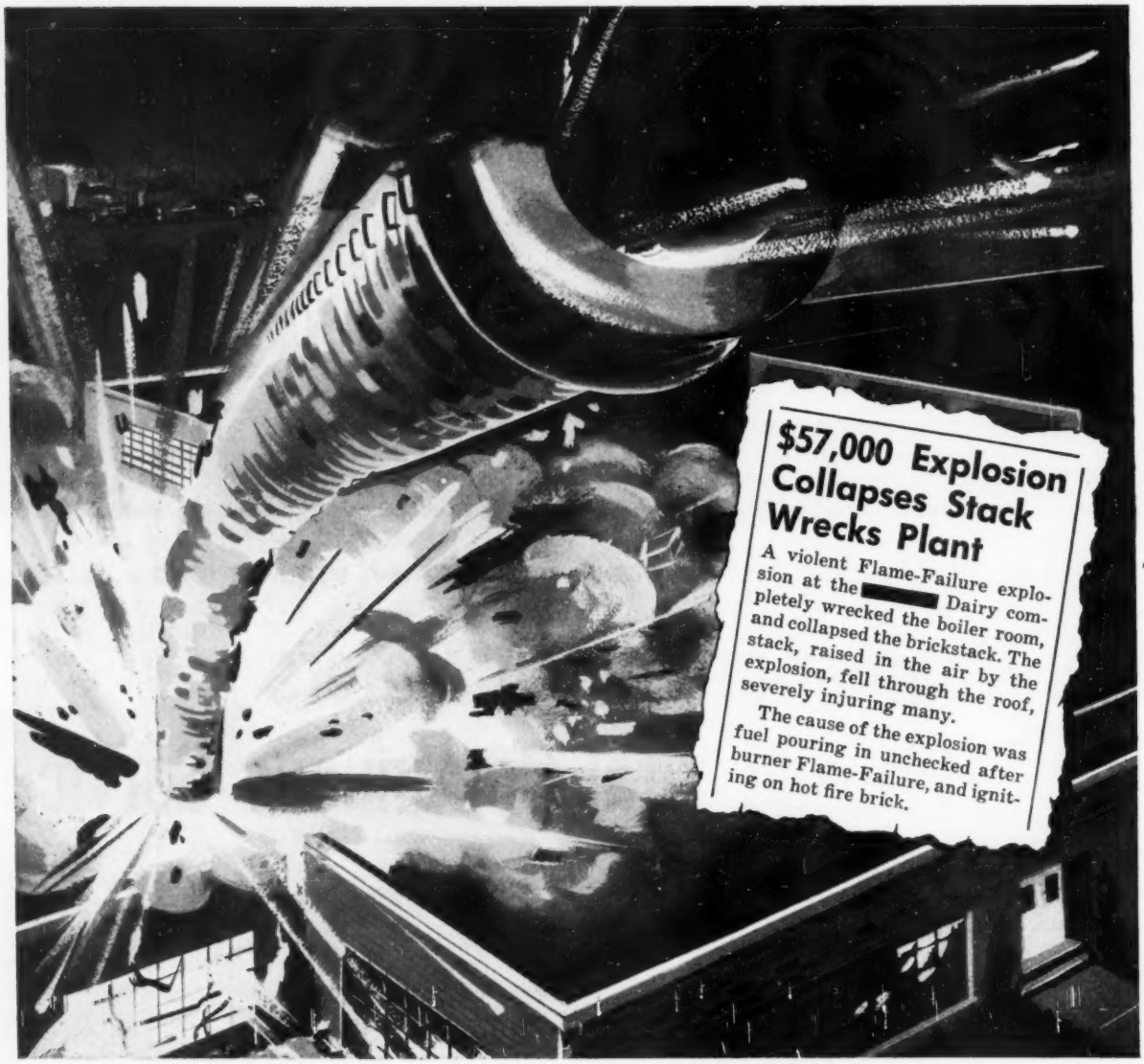
You get another big plus from industry's first successful outdoor weather-protected motor . . . the long-life quality developed in building over 2½ million horsepower of motors for power stations.

For complete information on these and many other features, contact your nearest G-E Apparatus Sales Office or write for Bulletin GEA-5810. General Electric Co., Section 753-5, Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

This explosion wrecked


$57,000 Explosion Collapses Stack Wrecks Plant
A violent Flame-Failure explosion at the [redacted] Dairy completely wrecked the boiler room, and collapsed the brickstack. The stack, raised in the air by the explosion, fell through the roof, severely injuring many.
The cause of the explosion was fuel pouring in unchecked after burner Flame-Failure, and igniting on hot fire brick.

COVERING THE U. S. A. and Canada, factory-trained field engineers provide "know-how" of Flame-Failure safeguarding with FIREYE.

a power plant . . .

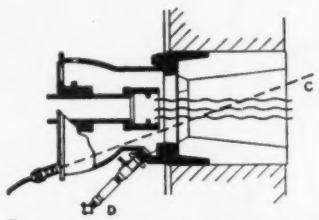
IF YOUR PLANT is like 4 out of 5 today, it is unsafe.

For 4 out of 5 plants burning oil, gas or coal simply do not have Flame-Failure protection that meets insurance company standards . . . *automatic safeguards for commercial and industrial burners should shut off fuel in 2 to 4 seconds after a burner Flame-Failure!* Explosive gases collect fast. Faster, actually, than most mechanical "safeguards" can act.

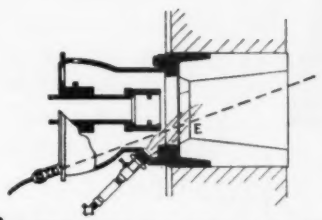
So don't depend on slow, half-safe controls that may be no protection at all. Act before it is too late in replacing them with a modern, fully approved FIREYE System . . . the only complete and instantaneous safeguard for all types of fuels. With FIREYE, an electronic eye "sees" the burner flame . . . works with the speed of light when it goes out, to cut off fuel and signal operating personnel.

Thousands of installations the country over, prove FIREYE has no equal for reliability. It can be applied to oil, gas, coal burners "overnight" — for a negligible investment.

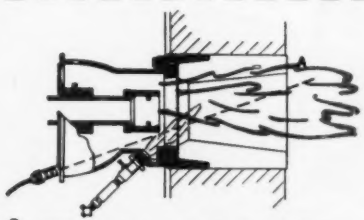
How fireye works to give you complete Flame-Failure protection



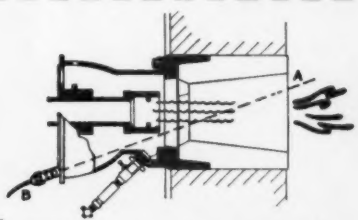
1. FIREYE purges combustion chamber (C) before igniting pilot (D). This eliminates dangerous gases which may have accumulated from leaking valve during down time.



2. FIREYE proves pilot flame (E) before turning on main fuel. Pilot may fail to light because of fouled electric ignitors, no fuel, or poor fuel-air mix.



3. FIREYE shuts down burner if main flame (A) is not ignited at end of safe-trial period (due to no fuel, poor fuel-air ratio or incorrect draft).



4. FIREYE shuts down burner in 2 to 4 seconds if main flame fails due to poor fuel-air ratio or draft, or fuel interruption. POSITIVELY PREVENTS EXPLOSION!

fireye®

UL FM

PLAY SAFE! SEND NOW!

Why take chances?

Even with modern equipment, the chances are 4-to-1 you do not have complete Flame Failure protection. Send for this new "primer" on explosion hazards that tells how you can make simple checks on the equipment you now have.

COMBUSTION CONTROL CORPORATION
Dept. PB-10, 718 Beacon St., Boston, Mass.

Send booklet "Guarding Your Properties Against Flame-Failure Explosions".

Name ..... Title .....

Firm .....

Address .....

City ..... State .....

FOR SEWARD, ALASKA . . .
a 15% cut in generating cost!
THE modern, turbocharged 1,150 hp Cooper-Bessemer diesel shown above represents Seward's latest step in better serving expanding industry and population growth.
Not only does this new diesel provide the city-owned Seward Electric System with an additional 800 KW . . . with the exceptional efficiency and
equipment, Seward's new unit produ
15% less cost!
If your plants call for new or expande
nies, better find out what you can sav
Cooper-Bessemer diesel, gas or gas
Check with the nearest office.
The Cooper-Bes
OGDEN SAVES $10,000 A YEAR ON FUEL ALONE!
. . with these Cooper-Bessemer Gas-Diesels
THE engines shown below are cost-cutting Cooper-Bessemer Gas-Diesels in the extremely modern, highly efficient Municipal Electric Plant at Ogden, Iowa.
Ogden's plant was completed in 1936. It was Cooper-Bessemer-powered from the start with three of these same engines, originally oil fueled. Following Cooper-Bessemer's development of the Gas-Diesel, the engines were converted and a new 12-8 Gas-Diesel added . . . in 1951.
Today, thanks to full Gas-Diesel operation and the high efficiency of these Cooper-Bessemer engines, fuel costs are actually running over $10,000 less than they would with full oil operation.
Why not check with us on the advantages you stand to gain with Cooper-Bessemer Gas-Diesels or other new-type Cooper-Bessemers on the job?
Another Example of Efficient Power at Lower Cost
The Cooper-Bessemer
GROVE CITY, PENNA.
Here's how
Gowrie Protected Citizens Against Rising Power Costs!
Another Example of Efficient Power at Lower Cost
GOOD NEWS for every town with a power proble
Gowrie, Iowa's $200,000 power plant is still generating power with rates no higher today than charged in 1934!
First, the Gowrie plant has always been a good example of what efficient management can accomplish in keeping operating cost down. But despite efficient plant operation it was necessary in 1949 to find a means of offsetting the still rising costs. More efficient, more economical power was needed. After a careful check of various engines, a 515 hp Cooper-Bessemer 15-6 gas-diesel was installed.
This new Cooper-Bessemer shown here, has been generating power for 6.02 mills per KWH. With Gowrie's original oil-burning diesel, the cost to would average 10.86 mills per KWH . . . 11% m cost than it takes to do the job with the modern un And Gowrie's new 15 is liquidating itself at a rate o 20% per year.
It's not an unusual case. Cooper-Bessemer gas-diesels are doing a dependable, money-saving job in hundreds of installations in all types of service. Get all the facts. They're yours for the asking.
The Cooper-Bessemer Corporation
MOUNT VERNON, OHIO — GROVE CITY, PENNA.
Another Example of Efficient Power at Lower Cost
36¢ PER HORSEPOWER PER YEAR!
. . . that's the maintenance score at Cleveland Southerly Sewage Plant with Cooper-Bessemers on the job!
In most anybody's book, maintenance cost is a key to overall engine performance and economy. So take a look at the record of the two Cooper-Bessemer 420 hp gas engines serving Cleveland Southerly . . .
These units, driving blowers, run on untreated digestion gas. In all 16 years of their service, they have cost Cleveland only 36 cents per horsepower per year for replacement parts.
Today you'll find this same kind of service engineered into the latest Cooper-Bessemer gas engines, diesels and gas-diesels — always with fuel, lube and space economies never before equalled! Get all the facts.
The Cooper-Bessemer Corporation
MOUNT VERNON, OHIO — GROVE CITY,

Savings everywhere...

WITH COOPER-BESSEMER DIESEL AND GAS-DIESEL ENGINES

AS the months roll by, we try to bring to your attention some of the many Cooper-Bessemer installations that are saving big money everywhere. Reproduced on these pages are a few of the ads telling how and where.

If you were to study and compare these "case records", you'd discover a similarity . . . a pattern. Boiled down it is simply this . . .

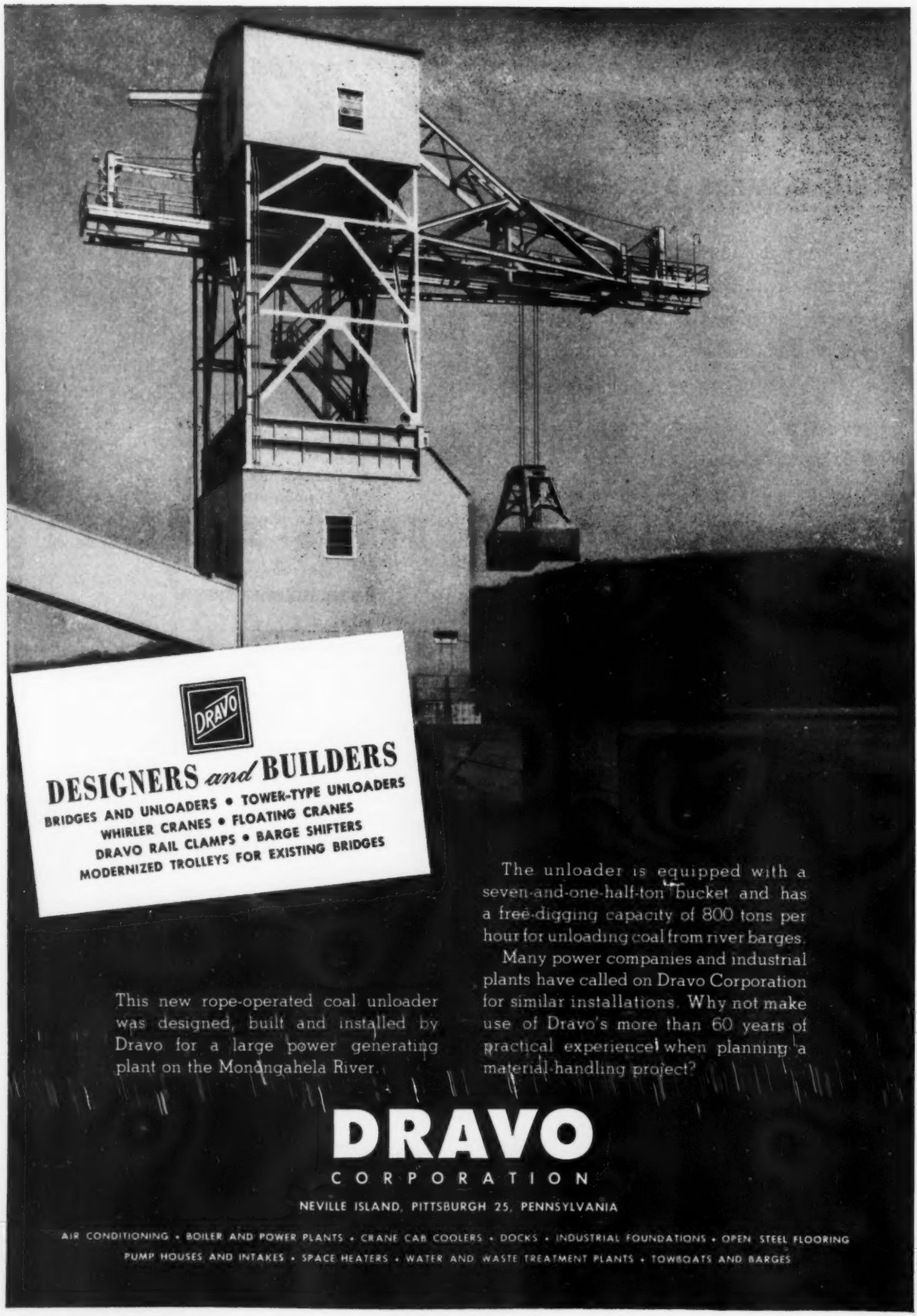
Cooper-Bessemers are exceptionally trouble-free, requiring minimum supervision and maintenance. Their design combines ruggedness with a *compactness* that cuts the cost of installation and housing. Finally, you get the full economy in fuel, lube and cooling cost that is possible only with the highest operating efficiencies reached today. And *that's* big!

Our nearest office is always glad to give you specific details on the Cooper-Bessemer units best suited to your power needs for today or tomorrow.

MOUNT VERNON, OHIO
COOPER-BESSEMER
GROVE CITY, PENNA.

New York Washington, D.C. Bradford, Pa. San Francisco Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle Shreveport St Louis Los Angeles Chicago Cooper-Bessemer of Canada, Ltd., Halifax, Nova Scotia Tulsa Gloucester, Mass. New Orleans, La.

Hominy saves $1148 a month on fuel with Cooper-Bessemer gas-diesel
How McGregor turned a Power Problem into $10,000 yearly profit!



DRAVO

DESIGNERS *and* BUILDERS

BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
WHIRLER CRANES • FLOATING CRANES
DRAVO RAIL CLAMPS • BARGE SHIFTERS
MODERNIZED TROLLEYS FOR EXISTING BRIDGES

This new rope-operated coal unloader was designed, built and installed by Dravo for a large power generating plant on the Monongahela River.

The unloader is equipped with a seven-and-one-half-ton bucket and has a free-digging capacity of 800 tons per hour for unloading coal from river barges.

Many power companies and industrial plants have called on Dravo Corporation for similar installations. Why not make use of Dravo's more than 60 years of practical experience when planning a material-handling project?

DRAVO

CORPORATION

NEVILLE ISLAND, PITTSBURGH 25, PENNSYLVANIA

AIR CONDITIONING • BOILER AND POWER PLANTS • CRANE CAB COOLERS • DOCKS • INDUSTRIAL FOUNDATIONS • OPEN STEEL FLOORING
PUMP HOUSES AND INTAKES • SPACE HEATERS • WATER AND WASTE TREATMENT PLANTS • TOWBOATS AND BARGES

You get more service continuity per dollar because this switchgear is standardized

Paul Pierson, Manager of Switchboard Engineering, explains why Westinghouse Standardized Switchgear is a better investment: all of your money goes into *equipment.* You don't pay for special engineering and special manufacturing techniques.

At the same time, you get equipment that's suited to your *particular* needs. Westinghouse Standardized Components can be assembled in any combination to fit your exact requirements. And Westinghouse Switchgear Assemblies have high salvageability . . . can be expanded, rearranged or relocated to meet future load conditions with only minor wiring changes and no loss in value.

Standardization means better service continuity, too. You can change these breakers in only three minutes because of the drawout feature. Built-in wheels enable you to roll the old one out and new one in. There's no lifting, no carriage—just a small dolly. You can be sure the new breaker will fit perfectly in the cubicle.

Because this switchgear is standardized, it has greater dependability. These proved features are an excellent guarantee against service interruptions: full steel barriers between compartments; automatic interlocks and insulated buses which provide the same degree of service continuity, at far less cost.

Why not visit East Pittsburgh and see how we build this extra dependability into Westinghouse Standardized Switchgear. Call us when you're in the vicinity. Meanwhile, write for B-5306, Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-60822-A

YOU CAN BE SURE...IF IT'S Westinghouse

...with TYCOL lubricants on hand!

Top this record! A well known utility company has operated a turbine for *almost 12 years* without an oil change or cleaning. At a rate of less than 10% "make-up" per year, Tycol Aturbrio has served the plant without malfunction – for years on end. And Tycol Aturbrio performance records show turbine after turbine running well over 100,000 hours without a change! That's *proven stability* . . . further substantiated by the regular use of Aturbrio as an outstanding hydraulic oil. Full data on Aturbrio performance is available from your local Tide Water Associated office.

Over 300 Tycol industrial lubricants are at your disposal . . . engineered to fit the job!

REFINERS AND MARKETERS OF VEEDOL . . . THE WORLD'S MOST FAMOUS MOTOR OIL

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C. • Pittsburgh
Philadelphia • Chicago • Detroit
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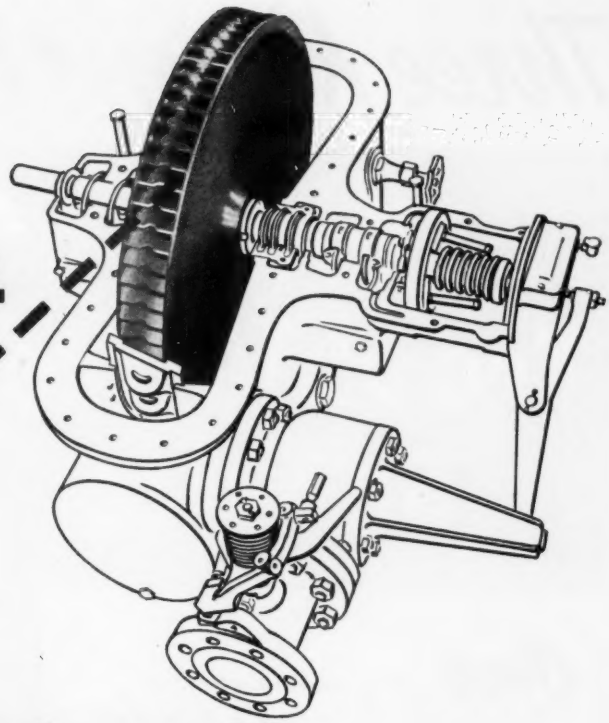
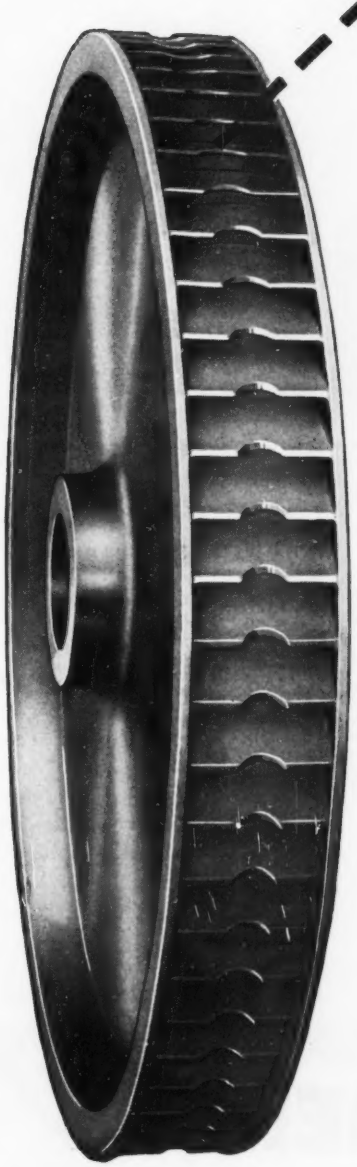
Toronto, Canada

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N. Y.

TERRY SOLID WHEEL





..."trade mark" of a trouble-free turbine

This is the rotor of a Terry solid-wheel turbine. There are a number of reasons why it has become a symbol for reliable, trouble-free operation.

First, because the wheel is a single forging, in which a series of semi-circular buckets is milled, there are no separate parts to become loose or work out.

Second, because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets, blade wear is of little consequence. Wear does not materially affect horsepower or efficiency.

Third, because the steam enters the buckets in a direction at right angles to the shaft, there is no need for close axial blade clearances. The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, the blades are double rim protected.

These are only a few of the reasons why the Terry solid wheel has become a "Trade Mark" for trouble-free turbine performance. For complete details, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

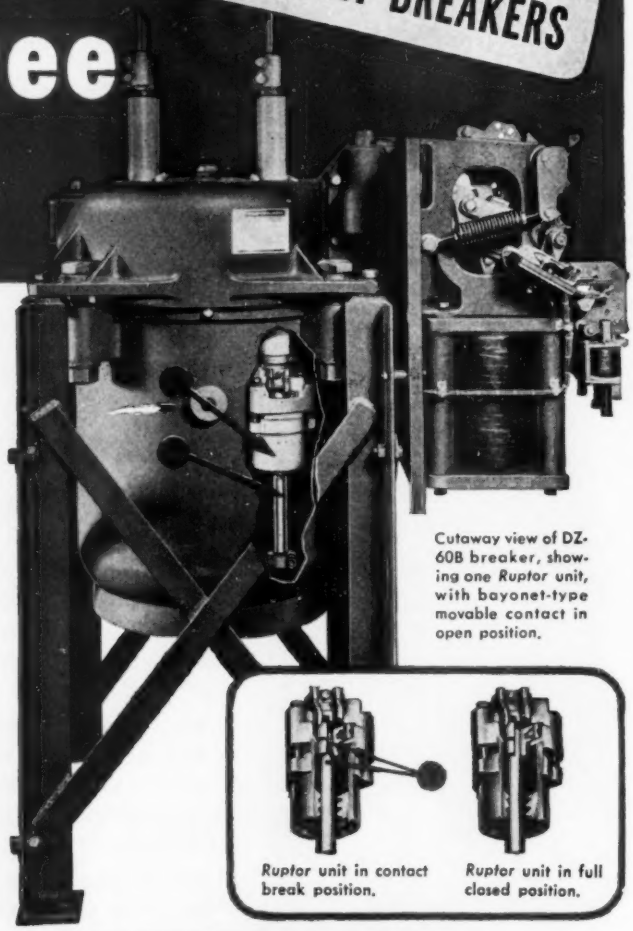
TERRY

TT-1197

Three Reasons Why

...Years of Trouble-Free Service

ALLIS-CHALMERS
Indoor
OIL CIRCUIT BREAKERS



Cutaway view of DZ-60B breaker, showing one *Ruptor* unit, with bayonet-type movable contact in open position.

Ruptor unit in contact break position.

Ruptor unit in full closed position.

One **Few moving parts!**

Bayonet contacts (1) are the only moving parts of the *Ruptor* interrupting device.

Two **Easy inspection!**

Drop the tank, and the bayonet contacts are visible in open position. For access to the stationary contacts, one needs only to remove four bolts and cylindrical shell (2).

Three **Self-aligning and Self-cleaning contacts!**

Tulip and bayonet contacts (3) maintain high conductivity without readjustment or cleaning. Arc energy is minimized by efficient interruption within oil-filled *Ruptor* unit. This in turn contributes to long contact life and low oil deterioration.

In addition, a mechanically trip-free solenoid operating mechanism controls contacts of time-proved *Ruptor* interrupting devices And pole unit mechanism is self-lubricated — completely enclosed — sealed from dust, dirt, corrosion.

In brief, Allis-Chalmers DZ breakers are built to assure years of dependable, trouble-free service.

Allis-Chalmers power circuit breakers are available in ratings from 2.5 to 230 kv, with interrupting capacities from 15,000 to 10,000,000 kva, to meet all industrial and power company requirements. For more information, call your nearby A-C representative, or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4057

Ruptor is an Allis-Chalmers trademark.

TYPE	RATED KV	MINIMUM KV AT RATED KVA	RATED AMPS	KVA INT. CAPACITY
DZ-40B*	7.2	2.3	600	100,000
			1200	100,000
			2000	100,000
DZ-60B†	13.8	4.0	600	150,000
			1200	150,000
DZ-100B†	13.8	4.0	1200	250,000
DZ-200B†	13.8	6.6	1200	500,000
			2000	500,000

*Ask for Bulletin 71B6179. †Ask for Bulletin 71B6129.

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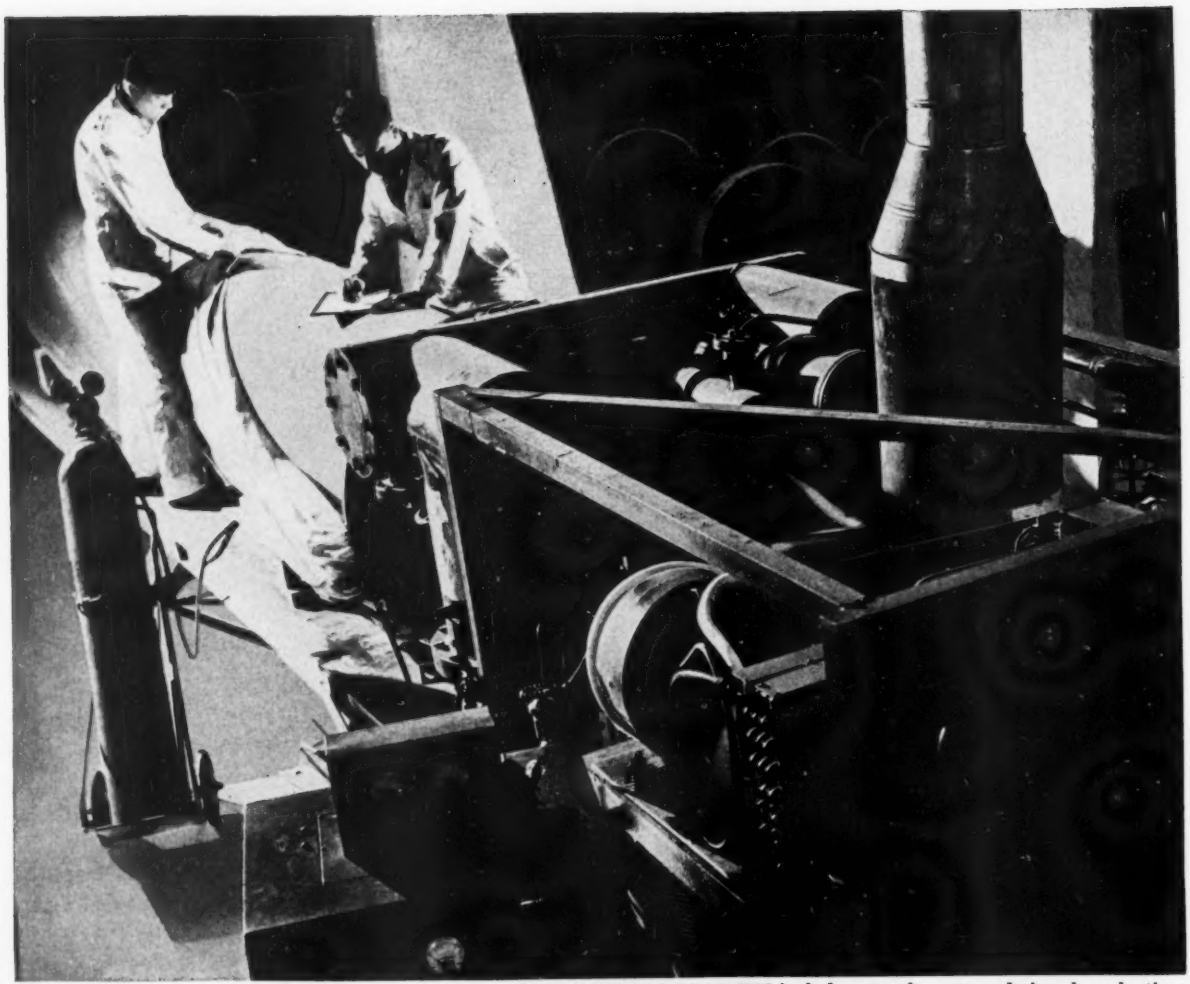


ALCO'S SPECIAL FACILITIES include not only custom-designed production machinery but also the most modern equipment for testing and inspection. Here, for example, Alco technicians use a mass spectrometer to inspect pipe welds for microscopic leaks. The mass spectrometer can detect leaks that would allow only one drop of water to escape in 100 years.

CHANCES are, that new demands in your industry have presented you with many problems calling for new and varied types of heavy metal equipment.

If so, take a tip from scores of power and processing companies the world over—*look to Alco for the answers.*

Alco has the facilities required to fabricate heavy metal equipment for almost any purpose (see examples on these pages). Equally important, Alco has the wealth of experience required for the design of that equipment.

We invite you to contact your nearest Alco Products Sales Engineer and give him the details on your most troublesome heavy-equipment problem. He will show you how Alco can design and build the answer that will give you maximum value for your equipment dollar—now and in the years ahead.

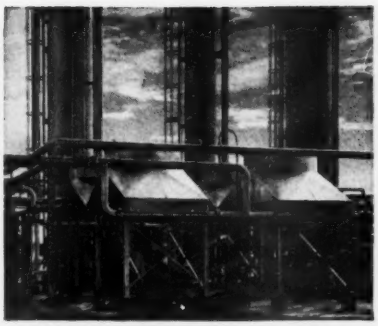
Alco Products Sales Offices are located in Dunkirk, New York, Chicago, Los Angeles, Kansas City, Houston, Tulsa and Beaumont.

Look to ALCO for...

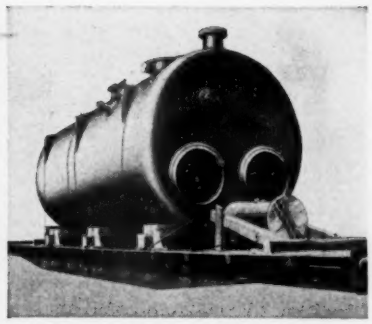
Answers to

Alco

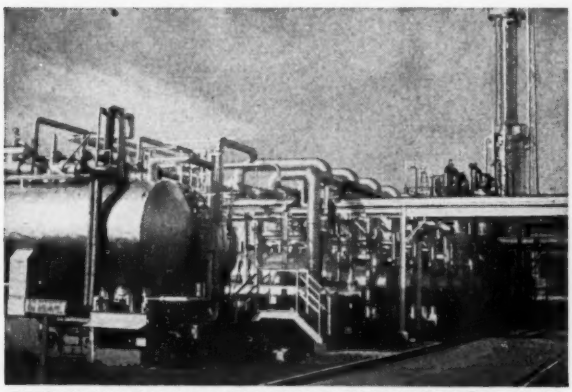
84-INCH ALCO STEEL PIPE at Croton Falls, N.Y., is part of the gigantic aqueduct system furnishing New York City with approximately 1050 million gallons of water per day. Alco Electric Welded Steel Pipe for interliners was also used in part of the New York City Board of Water Supply's new $44,000,000 East Delaware Tunnel, now nearing completion.



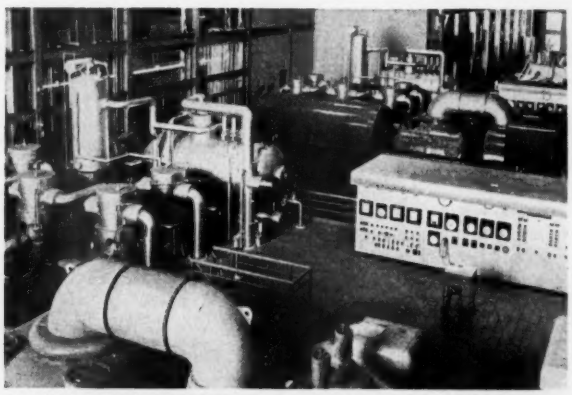
"UNI-BUNDLE UNITS" demonstrate the versatility of Alco Aircoolers. Vertical partitions welded in the headers allow several different vapor or liquid streams to be handled in a combined tube-bundle. Units are shown here at a large Southwestern natural gasoline plant; the one at right not only cools the oil but also condenses the overhead vapor from the steam.



HUGE TAR STILL, equipped with two corrugated furnaces for direct firing, typifies the virtually endless variety of heavy metal equipment built by Alco to meet special customer requirements. This is the type of equipment which has earned for Alco the confidence of power, petroleum and chemical companies all over the world.



REFRIGERANT HEAT EXCHANGERS AND STORAGE TANKS were among the variety of heavy-duty equipment built by Alco for Tennessee Gas Transmission Company's Hydrocarbon Recovery Plant at Gabe, Kentucky. Alco has over 50 years of experience in the design and fabrication of heavy-duty equipment for sub-zero operation.



ALCO FEEDWATER HEATERS AND EVAPORATORS were specified for the two 66,000 kw turbine-generator units installed in 1949 by Philadelphia Electric Company at its modern Barbadoes Island Station. Each evaporator delivers about 20,000 lb of make-up per hour. The feedwater heaters handle 555,000 lb of condensate per hour and deliver feedwater at 406 F.

New Industrial Problems

ALCO

ALCO PRODUCTS DIVISION

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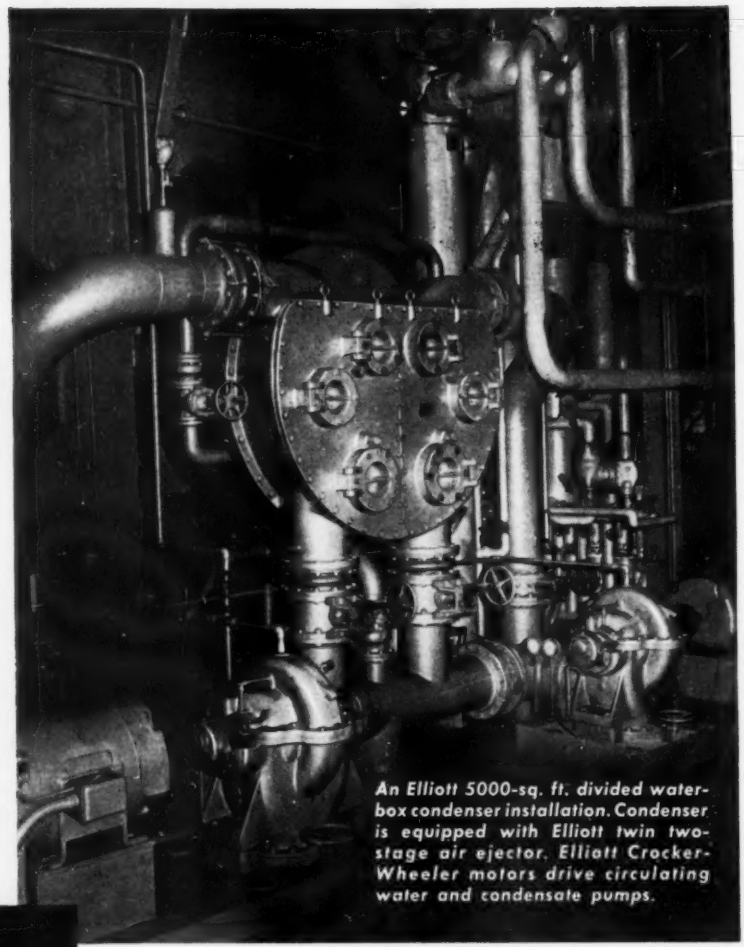
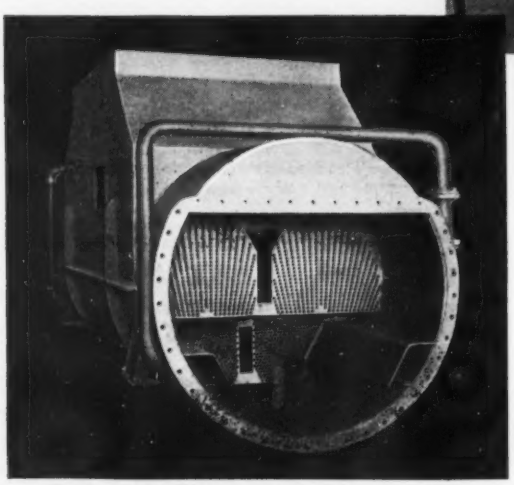
Elliott careful engineering builds better condensers



An Elliott 5000-sq. ft. divided water-box condenser installation. Condenser is equipped with Elliott twin two-stage air ejector. Elliott Crocker-Wheeler motors drive circulating water and condensate pumps.



This view of a 10,000-sq. ft. condenser with tube plate removed shows the fan type tube layout, partial tube supports, and air intake baffles.

THIRTY-FOUR YEARS of step-by-step development are back of the Elliott Type F Surface Condenser, and have resulted in a number of advances providing for better, more efficient operation. The most important of these results are:

1. *Maximum penetration of steam, with minimum pressure drop, due to improved tube layout.*
2. *Condensate temperature equal to steam temperature.*
3. *Minimum oxygen content of condensate.*
4. *Minimum terminal difference – the temperature difference between steam in the top of the condenser, and the discharge water.*

A further advantage in Elliott Type F condensers is the partial tube support design, in which support plates for the upper and lower tube banks are staggered rather than continuous, and thus do not divide the condenser chamber into cells, causing excessive pressure drop or dead spaces.

Type F condensers are built in sizes from 500 to 15,000 sq. ft., in both divided and undivided water-box type. They can be designed to meet specific space conditions. For details, contact your local Elliott engineer, or write Elliott Company, Jeannette, Pa.

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CONDENSER DEPARTMENT

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Curtis Whittlesey McGraw

1895 • 1953

Everybody who knows POWER has known Curtis McGraw, president and chairman of the Board of the McGraw-Hill Publishing Co. The enduring mark of his leadership in the task of keeping business well-informed, shaping the technical development of industry, and holding the nation to an awareness of its power for greatness and goodness must remain on these pages. But it is something out of the lives of all of us that he died last month.

Mr McGraw was 57 years old. His home was at 130 Hodge Road, Princeton, N. J. He was the third son of the late James H McGraw, Sr, founder of the publishing company of which Curtis McGraw had been president for the past three-and-a-half years. He is survived by his mother, Mrs Mildred Whittlesey McGraw of Madison, N. J., his wife, the former Elizabeth Woodwell of Princeton; a daughter, Mrs James L Stoltzfus of Lake Forest, Ill., and three brothers, Harold W McGraw, James H McGraw, Jr, and Donald C McGraw, and a sister, Mrs H S Rock. D C McGraw is vice-president of McGraw-Hill Publishing Co.

Born in Madison, N. J., Oct 13, 1895, Mr McGraw was a graduate of the Lawrenceville School, Lawrenceville, N. J., and of Princeton University, class of 1919. At Princeton, he was president of his freshman class, captain of his varsity football team in 1919, and was active in other sports.

He was a major of infantry in World War I and saw service in the Artois sector and Meuse-Argonne offensive.

Mr McGraw was a member of the Postmaster General's recently appointed Advisory Board of the Post Office. He was a past director and past president of the American Book Publishers' Council.

He was also a director of the First National Bank of Princeton, the Dragon Cement Co, the Princeton University Press of which he was treasurer, the Princeton Hospital, of which he was president, and the Magazine Publishers' Association. In New York, and nationally, Mr McGraw was associated with numerous civic, philanthropic and business organizations.

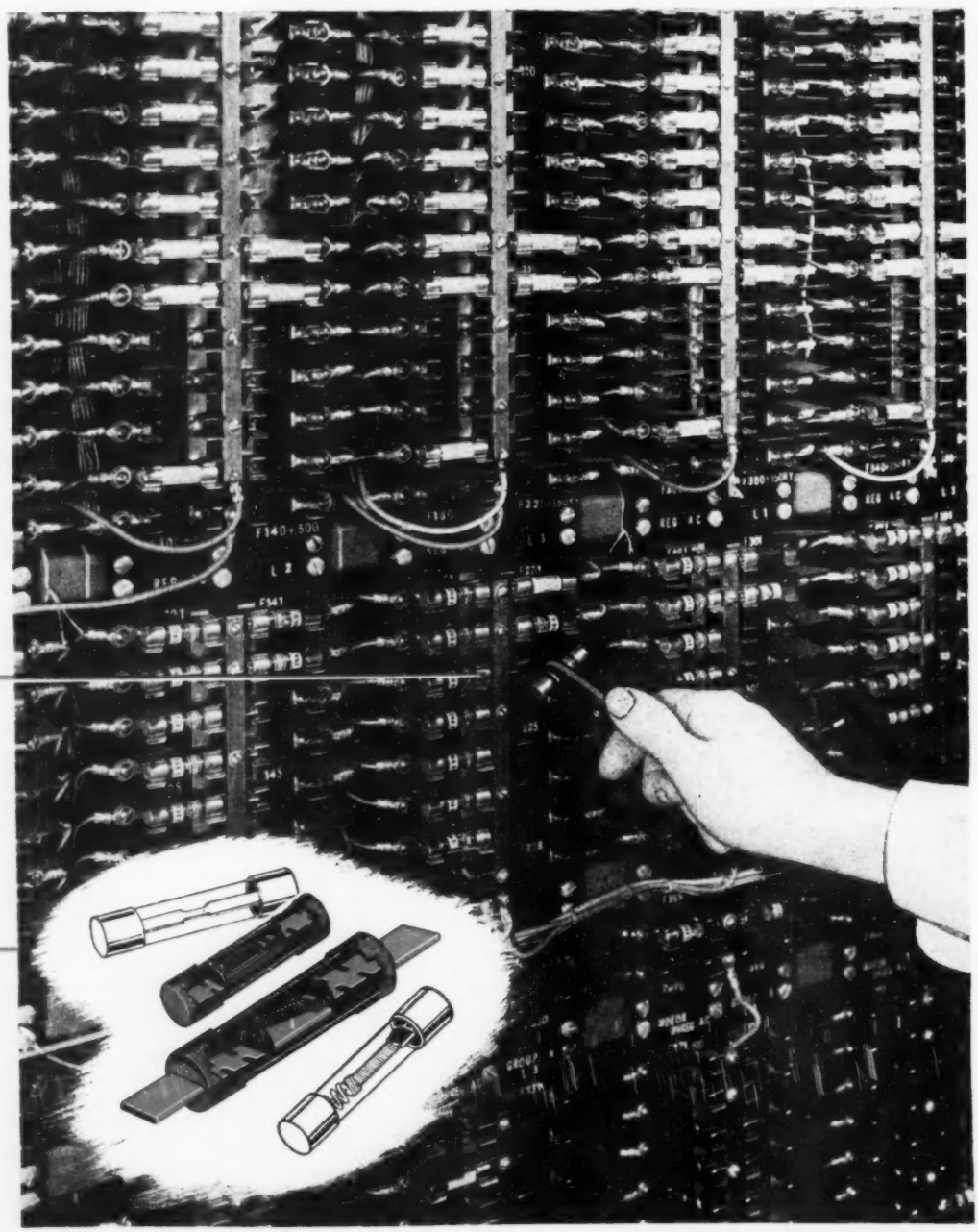
Associated with the McGraw-Hill Publishing Co since 1920, when he joined the McGraw-Hill Book Co (McGraw-Hill subsidiary), he was vice-president, treasurer and director of the Book Company from 1927 to 1950. He became vice-president and treasurer of the McGraw-Hill Publishing Co in 1943, and in February 1950 was elected president and chairman of the Board.

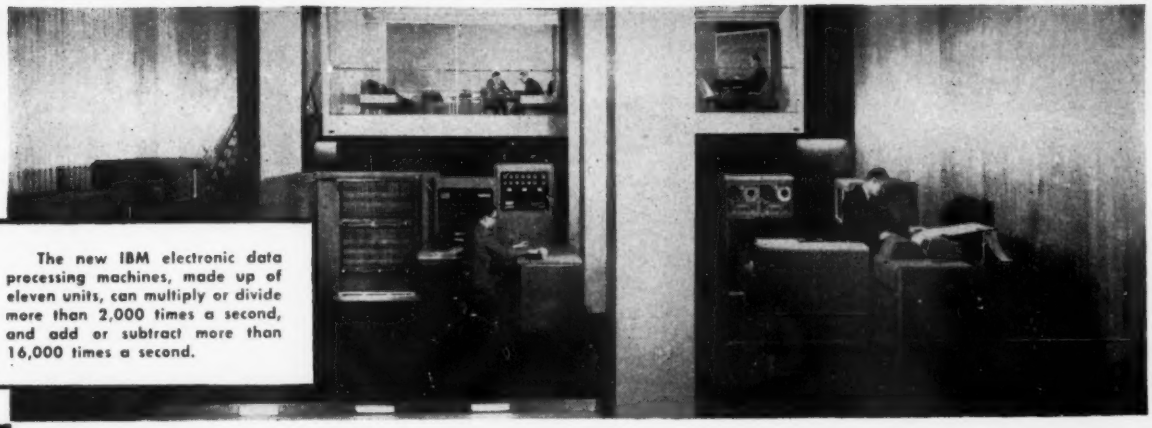
The following editorial appeared on September 11 in the *New York Herald Tribune:*

"The modern industrial society must be fed by streams of information, objective, expert and complete. It needs facts about all its separate parts—technical facts which may be wholly outside the layman's understanding and yet are charged with life and drama to those who make the multitudinous decisions of a free economic system. The McGraw-Hill Publishing Co has been a principal supplier of these facts. Its books, magazines and directories, sold not only in this country but across the world, have almost as important a role as oil or steel in shaping technical development.

"Curtis Whittlesey McGraw, who died yesterday, has presided with imagination and skill over the wide-ranging enterprises of the McGraw-Hill Company. Virtually his whole life was given to the work which his father had shared in founding. He was always ready to take part in civic enterprises, but the company itself is undoubtedly the memorial by which he would want to be remembered. As outward symbol of his contribution there stands at the west end of 42nd St the famous building designed by Raymond Hood, a landmark in the city. But in factories and industries without number there is some part attributable to the facts and information which poured forth through the enterprise of his company."

More Than 400 FUSETRON and BUSS Fuses are used in IBM's Electronic Data Processing Machines





The new IBM electronic data processing machines, made up of eleven units, can multiply or divide more than 2,000 times a second, and add or subtract more than 16,000 times a second.

In these electronic data processing machines, protection of the intricate wiring is of the utmost importance. IBM uses between 400 and 500 FUSETRON and BUSS fuses in each of its new '701' high speed calculators.

On circuits where surge currents might cause an ordinary fuse to blow needlessly, IBM specifies FUSETRON dual-element fuses because of their long time-lag. On other circuits where no surges occur, or where even a short-lived surge might cause damage, single-element BUSS indicating fuses are used for fast opening in case a fault occurs.

When this newest and most powerful high speed electronic calculator was displayed at IBM World Headquarters on March 27th of this year, FUSETRON and BUSS fuses were one of the component parts that made the operation of this spectacular machine possible.

You Can Have The Same BUSS Dependability and Accuracy in Your Plant . . .

FUSETRON dual-element fuses for the protection of industrial and commercial circuits are made with the same precision demanded for this ultra-modern IBM equipment. That's why FUSETRON fuses, used throughout the entire electrical system give you a degree of protection obtained with no other device.

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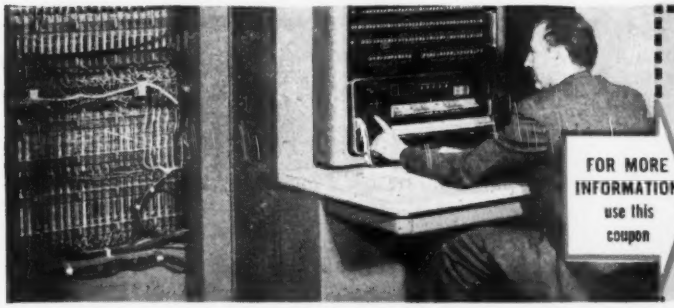

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Today's Electrical Practice

supply / distribution / utilization – in the industrial plant

a special report — October 1953 — **Power**

by James J O'Connor, Associate Editor

In this report, we've done what you'd want to do if you were starting to plan a new electrical system or modernize an old one — probe the thinking of the country's top experts to learn the best current practices in equipment and installation.

For this unique job we used unique editorial methods. To begin with, we enlisted the cooperation of technical specialists of some 40 companies — manufacturers and large users of electrical equipment, consulting engineers. Right here we'd like to acknowledge in the warmest way the invaluable assistance given freely to us by all concerned.

To each specialist we sent a carefully planned outline for advance study. Then, armed with a recorder, we sat down for discussions with each. Recorded summaries of these talks formed our raw material.

Next came the job of bringing together and evaluating these facts and opinions. The final result represents our best judgment in assessing often-diverse points of view. We believe it is a fair concensus.

Finally, to make this concentrated mass of information easy to read and handy for future reference, we tried to organize it carefully into logical sections and subdivisions. Index below shows the structure.

Here, then, you have a complete rundown on today's industrial practice. Use it as a check list to make your electrical system topnotch in all respects. And remember that many of the ideas presented here apply with equal force in institutional plants, buildings, central stations.

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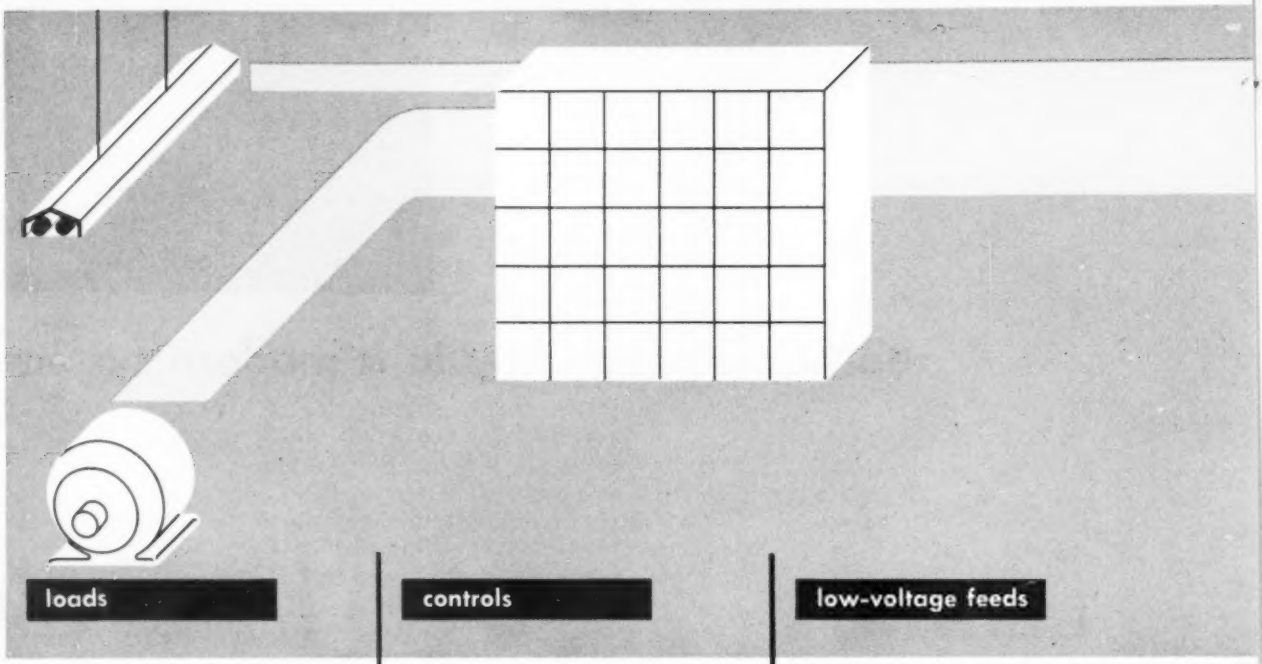
early planning—key to a modern system

1 **Load studies** come first — determine size, nature and characteristics. Estimate lighting and power loads separately, then combine. Be sure to allow for future growth, and for flexibility.

2 **Distribution-system** planning involves decisions on voltage, grounding, type of system, substation location, type of transformers, methods of carrying primary feeds, circuit protection.

3 **Power-supply** thinking starts with study of purchased energy vs generation. If you decide to generate, investigate equipment needs. For utility supply, check reliability, voltage regulation.



Know demands of present and anticipated loads – voltage, current, starting requirements. Will ambient conditions dictate special insulation and enclosures? Try to standardize motors and lighting to cut stock, increase flexibility. Will motor loads allow combining power and lighting feeds? What about pf?

Study control needs in light of speeds, torques, inrush, protection. Should controls be grouped in centers, or spotted at each machine with bus-duct feed? Remember package equipment often cuts over-all costs. Be sure control units will hold up under possible short-circuit currents. Decide on use of fuses and breakers.

Select secondary distribution voltage – 480 v? Grounded or ungrounded neutral? Will bus duct or conduit-cable best serve most plant needs? Plan the runs to hold down voltage drop. Do corrosive atmospheres require special finishes? Will lightweight aluminum conductors reduce installed cost on secondary runs?

To plan the best electrical system, study your loads first, then...

Whether you're modernizing or building new, you must start by making some broad decisions about supply, distribution and utilization. How well you handle this early planning just about determines whether the electrical system will be adequate for present needs and, even more important, whether you'll be able to expand it economically in the future.

Load Survey. Since end purpose of the system is to handle present and future loads, planning starts with the load—magnitude, nature, characteristics.

Look into size first—both supply and distribution setups hinge on it. (More about this later.)

Nature of load – motors, lighting, welding, heating, etc. – is important from the distribution angle. Motor and lighting loads are often supplied by same feeds, but welding is generally segregated.

Are loads intermittent or continuous? If continuous, how costly is an interruption? How far would it pay to go in providing extra reliability?

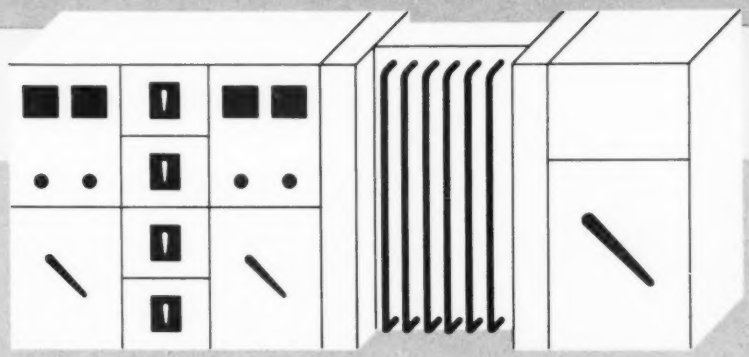
Load Estimating. Accurate load estimating isn't easy, especially for a new plant where the using equipment is in the planning stage also. You can only work from data at hand, then check and supplement with figures from similar plants.

Start by considering light and power separately. Combine them later to determine demand in various areas, since both often come from the same substation. In manufacturing, load figures are usually expressed as *load density*, in volt-amp per sq ft.

Lighting loads are easier to estimate than power. Consider three factors: intensity, type of light source, fixture height. Lighting load density will vary from 1 volt-amp per sq ft in storage areas to 8 for precision manufacturing or small parts assembly. If you don't know outdoor-protective-lighting needs, allow about 10% above total indoor lighting load. Much estimating help will be found in booklets issued by lamp and fixture manufacturers.

Power-load estimating is tougher. One way to start: Look first at major loads such as big synchronous motors, furnaces, etc. These strongly influence demand. Wrestle with them early, since their size and operating schedules can usually be predicted closely. For large induction and 0.8-pf synchronous motors, assume kva demand equals hp rating. But for 1.0-pf motors, assume kva equals 0.8 hp. Be sure to consider and take full advantage of diversity.

You'll need experience and a good picture of your plant's manufacturing activities to estimate demands of smaller machines on a load-density basis. In any one plant, density may vary from zero in storage areas to 35 volt-amp, or more, in some machine areas.



unit substations

Spot them close to load centers, in low-value space. Will sealed dry transformers show long-term savings over vented dry-types or askarels? Add enough safety factor on breaker ratings to handle future possible short-circuit currents. For future loads: specify spare breaker space in unit subs, leave room for additional switchgear. Secondary ties between subs improve service continuity. Will double-ended subs pay off in your plant? What is optimum size of each unit substation?

primary feeds

Will simple radial system suffice? Or do process-continuity needs justify selective or network arrangements? Will feeders be overhead or underground? Cascading breakers may cut first cost but prove a poor choice in the long run. Primary voltages to 15 kv may be carried right to secondary subs. High-voltage armored cable run overhead may give you lowest cost reliable installation. Hold voltage within limits; voltage regulators or load-ratio equipment may be necessary.

...decide which distribution system and equipment fit your needs...

Typical load densities for representative industries may be found in handbooks and manufacturers' literature. Use them only as a guide—your plant may differ from the typical.

Total load estimates fix system capacity, after allowing for demand and diversity factor. These, too, must be based on knowing your conditions, on past experience, and on data from similar plants.

Future Loads. Given reasonable care, load estimates are sufficiently accurate. Big mistakes are likely to come in connection with future loads—either in ignoring them completely or not allowing for them intelligently. Best bet is to avoid trying to guess what load growth may be. Instead, make "paper" plans for what should be done if it doubles, triples, etc. Fortunately, modern distribution equipment lends itself to easy additive growth.

Space is often a limiting factor. At the start, allow for added substations, primary switchgear, generators, etc, but plan on space in "low-value" areas. Provide enough spare ducts, conduits, etc, so added feeds can be run through the plant without disturbing the existing structure.

Flexibility. Your electrical system should be able to accommodate changes in manufacturing processes. Unit substations, easily added to or moved, are a big help in this. So is plug-in bus duct, which simplifies shifting production equipment. From an over-all point of view, try to anticipate future electrification of equipment now using steam or fuel—ovens, etc.

Distribution-system plans come next

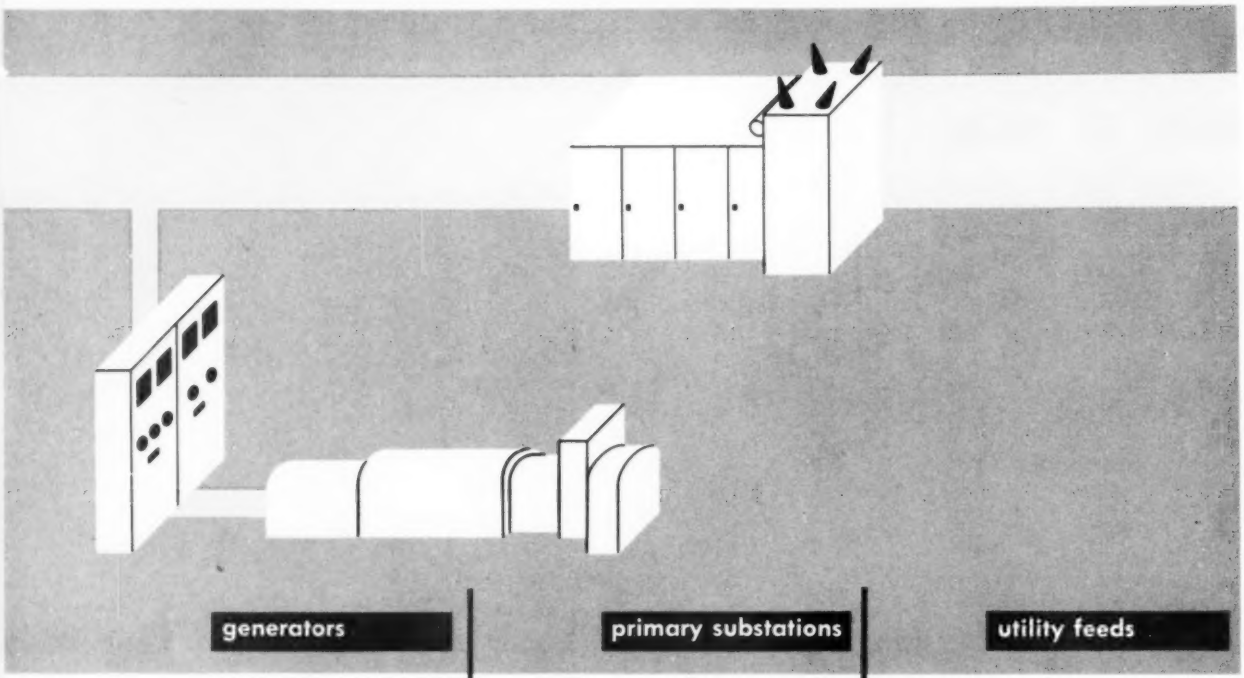
Once load needs are found, plan the distribution system. First question: What's best voltage? Decision often hinges on size of largest motor. Bear in mind that voltage trend, for good reasons, is up.

Neutral Grounding. Look into this matter early. Except in some plants where continuity of service to critical loads is involved, more and more are grounding both primary and secondary. Some plants, for the time being on an ungrounded system, provide for simple changeover to neutral grounding by using Y-connected transformers with neutral ungrounded.

Operating simplicity is keynote in selecting a distribution system. Most plants use a simple radial system. But consider value of extra reliability given by primary or secondary selectivity. If your plant has heavy concentrated loads, look into network systems.

In any case, you'll want to eliminate long low-voltage runs from primary substations by spotting secondary unit substations at or near load centers.

Try to plan substations in low-value space. In



Check possibilities for economical generation: Total-up plant process-heat needs as a yardstick. Is low-cost or by-product fuel available? If generation is indicated, what size units? How many? In planning layout, remember modern designs save basement space by banking cooling equipment alongside unit.

Decide early on ownership and location. Lower rate often goes with ownership but don't forget fixed charges, maintenance. Reliability of today's transformers justifies using one 3-phase rather than 3 single-phase units. Where utility feeds come in over long overhead lines, check lightning protection at substation.

Can utility supply plant's demands economically? Strive for several feeds coming from separate sources. What voltages are available? Agree on switching procedure to keep plant operating in emergency. Explain working schedule to utility so they can handle their maintenance without interrupting your feed.

...and finish your planning job by making decisions about supply

today's spread-out one-story plants, substations on the roof work well. There they can be reached easily by primary feeders. Or, consider putting them on balconies, up out of work zones.

Oil-filled transformers are still first choice for outdoor primary substations. Indoors, shift is away from vaults to askarel or dry type. Look into sealed dry-type where dust, moisture are problems.

Primary Feeds. Choice for carrying them through the plant boils down to overhead vs underground. Underground is out of the way, unaffected by weather. But overhead offers lower initial cost, can be expanded readily. Keep feeders out of valuable work space—overhead trusses form good supports.

Circuit Protection. A real *must* here is a knowledge of possible short-circuit currents. If you're fed from a utility, have them supply values at primary substation. From that point on you can determine what values will be at any point on your system.

With voltage, hp ratings of load, and possible short-circuit values, you have basic data to select switchgear. For primary substations, give thought to economics and advantages of both circuit breakers and load-interrupter fused switches.

Now you've worked your way back to the beginning of the system—power supply. Big question: Purchase or generate? For some factors to be checked, see pp 80, 81. Here are some points to consider in planning for either plant generation or utility supply.

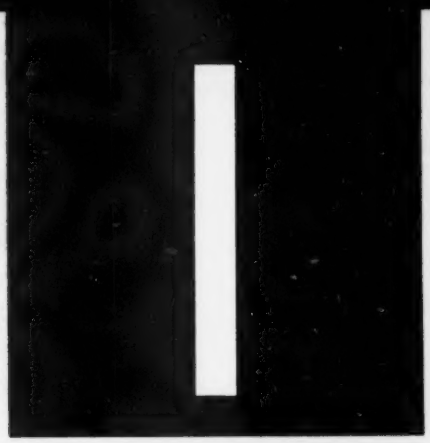
Supply plans finish the job

To select size and number of generating units, check your maintenance-shutdown schedule, which critical loads must be carried and which may be dropped, how much load, if any can be shifted to the utility, starting kva of large motors. Can a power-interchange contract be worked out with the utility?

If you plan to purchase, check your utility's ability to supply your load; power supply remains tight in some areas. And be sure utility knows what your demands, load swings and load factor will be.

Utility Feeds. For critical loads, study utility's system for supply reliability. If only a single line serves you, it may pay to bring in an additional one. Check voltage regulation. Starting large motors may be a problem if your plant is at end of a long line. Voltage regulators on utility line or load-ratio control on transformers help hold voltage up.

For many plants, parallel operation with a utility is a good bet if it can be arranged. Consider value of provisions for quick disconnection if lightning is a problem and continuous processes are involved.



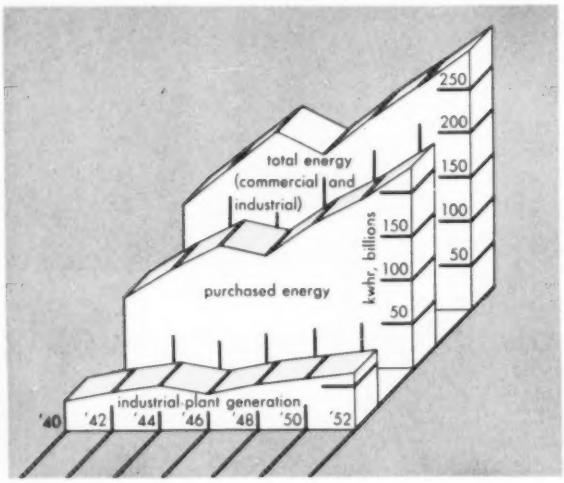
setting up your plant's power supply

1 **Generation.** Relate generating-unit and load characteristics to determine number and size. In selecting generator itself, consider short-circuit ratio, cooling, regulation and voltage level.

2 **Utility Feed.** First work out details of primary substation ownership, number of feeders, voltage, etc. Packaged equipment usually proves most economical. Check voltage-regulation needs.

3 **Protection.** Now overcurrent relays with voltage restraint can tell faults from permissible overloads. Transformer at primary substation should be guarded against surges and overloads.

1 when to generate



Industrial power generation has risen slightly in recent years but nowhere as fast as has amount of energy purchased. This relative decline in industrial generation stems from the fact that, in general, the small private plant is less fitted to cope with rising costs of fuel and labor than is the large central station. Yet in spite of this general trend, decision to make or buy depends on the often complex economics of each individual situation.

Purchasing energy avoids need to make a relatively large investment in generating equipment. Many industrialists today believe that capital invested in manufacturing facilities yields a greater return. They also believe that purchasing energy gives more economic flexibility to meet business slumps, or changes in markets and products. And they feel it shifts problems of operating and maintaining generating equip-

If you decide to generate all your needs, or part, study factors . . .

If you decide to generate, you need to look into some basic considerations of generator selection—size and number of units, and their characteristics.

Generating Units. We use the term "generating units" advisedly, since performance of the prime mover is perhaps even more important than that of the generator and we must always think in terms of the combination. Here are some considerations that affect decision on number and size of units:

In general, cost per kw of generating units goes down as size goes up. Efficiency usually improves as size goes up. (This is notably the case with steam plants; efficiency of diesel and hydro units doesn't change as markedly with size.) Operating labor costs are more nearly proportional to number of units installed than to total plant capacity.

In any given generating unit, efficiency varies with load. It's usually low at light loads, rising to a "best point" somewhere between 75% and full load and falling off slightly at higher loads. Shape of the efficiency curve depends on type of prime mover, and to a lesser degree on size, design, etc.

Nature of Load. Above characteristics of generating units point in the direction of supplying load with one large unit. Yet this is rarely possible because of load conditions.

Take the question of continuity, for example. Where operation is continuous and interruptions are costly, reserve capacity is indicated, not only for forced outages but for scheduled maintenance outages. It's usually more economical to provide reserve for several smaller units than for one large one. A typical setup might use three units, any two of which can carry the load. This also provides economically for load growth—adding a unit gives four machines with any three able to carry full plant load. Where continuity is a factor, always check to see what standby service, if any, your utility can provide, and what it costs.

Load factor also exerts strong influence. Low load factor works against use of one or two large units since much of the operation would necessarily be on the low part of the efficiency curve. A special problem in some industries is weekend load, which may require a special small unit. The load-duration curve proves a valuable device for re-

Also consider layout of cooling equipment, exciter cooling and speed, generator . . .

In the past, generator air coolers were usually in the basement directly below the machine. Today's units offer them built into the frame or directly alongside it. This is important where noncondensing units are used since the basement may be eliminated. Choice depends on a comparison of cost of basement construction against increased cost of generator with cooler built in or alongside. Don't overlook reduced ductwork and installation cost and easier maintenance of the above-floor layout.

Exciters. Separate cooling systems for generator exciters are now available. One justification for a separate system is the difference in cooling requirements. Reducing cooling pressure in the exciter rules out possibility of air bubbles working their way in and through bearing lubricant.

While you look at the exciter from the cooling angle, consider its optimum speed. This applies particularly to engine-driven generators running below 600 rpm. In such cases, consider belting the exciter so it operates at a higher speed. Think in terms of a maximum speed of 1750 rpm to get maximum speed of response in your voltage-regulating system.

Regulation. Standard generator regulation figure of 40-45% at 0.8 pf will satisfy most requirements. But there are exceptions. Typical would be the case of a paper mill, where the large chipper motor, biggest single load, would influence selection of generator capacity and set a precise voltage-regulation requirement. Starting needs of this single heavy load might materially change the 40-45% figure above.

Generator Voltage. In general, generator voltage is a function of load size, distance from generator to load, voltage of connected system and, in a growing number of cases, the size of the largest single load unit.

Standard voltage ratings for various generator sizes are catalogued by NEMA as follows: For small ac turbine-generators in the 75- to 400-kw range, standard ratings are 240, 480, 600 and 2400 v. For geared-turbine synchronous generators 500 to 1500 kw, voltage range is anywhere from 240 for 500 kw to 4160 for 1500. Minimum standard voltage for 1000- and 1500-kw units in this class is 480 v. All other geared units can

ment to a specialist in them – the utility company. **Private generation** should be considered in many cases, however. It often proves economical in industries where large quantities of process heat are required, particularly where the relationship of heat and power loads is such that all or most of the electrical energy can be generated as a byproduct of process-heat demand. Availability of cheap byproduct or waste fuels also favors generation.

Even without process demands or byproduct fuels, private generation may pay in large plants with high load factors, where conditions approximate those which permit efficient utility operation.

And, in rare cases, you may not be able to buy what you need, in terms of amount, reliability, etc.

In all cases, make a complete study and don't overlook possibility of buying part and making part.

Is outdoor generation practical?

Rising building costs make outdoor generating facilities look more attractive. Yet among central station designers who have had wide experience with outdoor construction there's still less than full agreement as to how far it pays to go.

Against savings in building structures you must stack cost of protecting outdoor equipment and, some say, higher costs of operation and maintenance influenced by weather conditions.

Certainly, if your new plant will enjoy a favorable climate, look into the many possible outdoor and semi-outdoor layouts. Check carefully into effects on operation and maintenance. And if you decide to go outdoors, be sure to "sell" your operating force on the practicality and merits of it.

. . . *affecting size and number of units, look into short-circuit ratio*

lating unit sizes to plant load conditions.

Problem of obtaining a good balance between process-steam and electrical demands also influences number of units, since more than one type of steam turbine may be required.

Generator Characteristics. Now let's look at the generator itself. Start by checking characteristics as catalogued in manufacturers' literature. Standard-design generators meet most ordinary requirements but a "special" may be the answer to highly fluctuating loads, pulsating driving torques, abnormal power factors, especially leading or unbalanced single-phase loads. Where you intend to operate new generators in parallel with existing units, make sure that prime-mover, governor and generator characteristics are compatible.

See that the generator is able to withstand any overspeed it may meet in service. This is generally 85 to 100% for waterwheel generators, 25% for engine-driven and 20% for turbine-driven units. In probing the characteristics of industrial generators it's a good idea to consult suggested specifications proposed by NEMA for the type of generator unit under consideration.

Short-Circuit Ratio. Met in every generator specification, the term *short-circuit ratio* (scr) may not call immediately to mind its full meaning. The textbook definition is "ratio of field current required to produce rated voltage at rated speed and no load to the field current required to circulate rated stator current when operating at rated speed under sustained short-circuit conditions."

What significance has this in an industrial-generator specification? High scr gives desirable voltage stability characteristics, but to get it designer must put more copper and iron in the generator. This means larger housing and structural parts, greater weight, higher cost. Other drawbacks are higher initial and sustained short-circuit currents and some increase in generator losses.

But today desired stability characteristics can be obtained at lower scr values because of improved excitation systems. These are more sensitive and able to produce the rapid and large changes in field current needed to accommodate new conditions. Trend over the years is to lower values of scr, smaller and less costly generators.

. . . *regulation and voltage rating. Remember — voltage trend keeps moving upward*

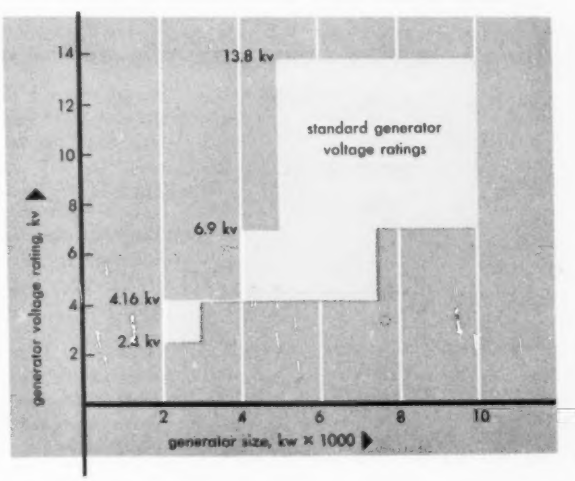
be supplied at 240, 480, 600, 2400 and 4160 v. Stick to these standard voltage ratings; where possible select the highest.

In still larger sizes, namely direct-connected turbine-generators rated 2000 to 10,000 kw, inclusive, available voltage ratings are shown in the chart, *right*.

In all questions of generator voltage, keep in mind the trend toward generating at higher voltages (up to 13.8 kv) and distributing at that voltage to secondary substations.

Modernization. In any modernization program, review the voltage question completely. Always think in terms of higher generator and distribution voltages; transformers will serve well to tie sections at different voltages. In adopting higher voltages study the insulation techniques used by each generator builder. How the maker copes with winding bracing and insulation problems in general may affect your maintenance requirements for years to come.

If you plan, at some later date, to swing from delta to Y connection to boost generator voltage, make sure the generator is now connected delta.

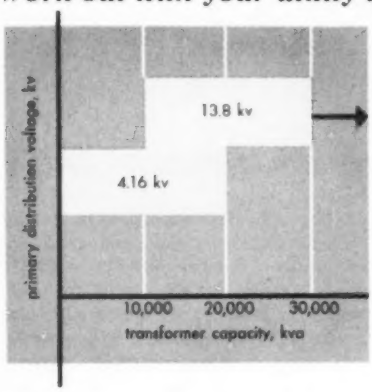


2 utility feed

The primary substation takes in electrical energy in bulk, trims its voltage to proper level and dispenses it. Transformation is often eliminated where utility voltage is below 15-kv ceiling set by NEC for most installations. But it may be in order even then, if big motors or other loads operate best at some voltage other than utility's. Three features stand out in any study of primary substations: *location, reliability, and protection.* **Location,** if ideal, would be right in plant load center. But practical angles and utility requirements usually put it at edge of plant property. Modern equipment enclosures make outdoor building-less installation the rule rather than the exception. Additional cost of outdoor gear must be balanced against building costs. Some strive for outdoor location of utility switching and transformers when over 15 kv, put plant primary switchgear indoors.

Where corrosive fumes, residues, may settle on high-voltage insulators, study indoor design. Or at least put substation on windward side of source and outline problem to equipment manufacturer. **Reliability** of your system can't exceed that of utility supply. So check its adequacy. Ask utility for

Work out with your utility the details on primary substation ownership, number of . . .

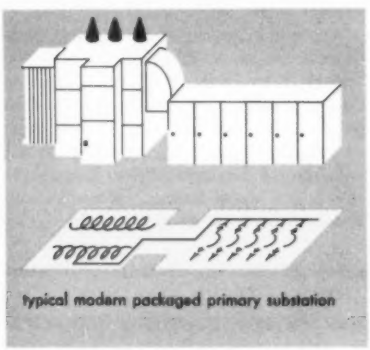


Tie down basic points early. Set number and arrangement of feeds by joint agreement. Decision hinges on: size of load, need for duplicate service, voltage, transmission-feeder capacity and nearness. Incoming feed may vary from 2.4 kv ungrounded to 138 kv with neutral grounded solidly or through resistance. **Type of feed** and high-voltage switching hangs on supply voltage, service continuity, load size, short-circuit-current available, utility relaying, number and size of stepdown transformers, flexibility needed for future load changes.

Utility feed may be a simple tap on a main transmission line, or line may be looped into primary substation, giving, in effect, a 2-circuit feed. More feeds may be brought in, from separate bus sections of utility substation or separate substations. Whether automatic or manual throwover is used depends on continuity required. Short-circuit duty remains relatively constant regardless of number of lines brought in, if they're not paralleled.

Who should own the primary substation? There's no universal answer. Where a choice is offered, many pros and cons can only be settled by an

Modern packaged substation designs, with single 3-phase transformers, cost less . . .

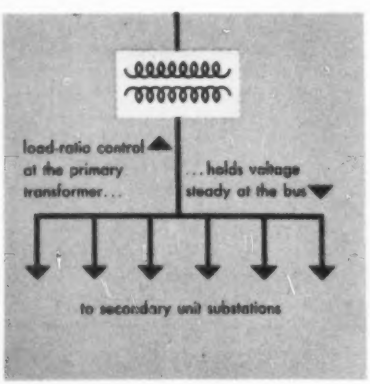

typical modern packaged primary substation

Today's packaged unit substation usually proves a better bet than stations assembled on the spot. Equipment cost may run higher but, with proper planning, installed cost shows savings and you have a smart, well-coordinated unit. **Primary unit substations** are made up of one or more transformers mechanically and electrically coordinated with one or more switchgear assemblies. Incoming section provides for high-voltage circuits, which may or may not have individual breakers. Transformer is usually oil-filled (see pp 96, 97). Outgoing section handles plant primary feeders with either breakers or load-interrupter switches and power fuses (pp 104, 105).

Weigh advantages of transformer fan cooling. Some engineers peg transformer size on existing load, then provide for later fan cooling. How much extra capacity this gives depends on unit size. The peak is 67% for 2-stage cooling in transformers over 10,000 kva (p 96).

Single-phase vs 3-phase transformer question is now pretty well settled. Reliability of today's units makes the single 3-phase transformer the logical and economical choice. Some engineers still feel there are cases, in large sub-

Today's critical loads generally dictate need for load-ratio control or regulators to . . .



Motors, lamps, heating equipment are all designed to operate best at rated voltage. Distribution systems aim to provide this but the best system suffers unavoidable fluctuations in supply voltage and voltage drop.

Today's industrial plant aims to hold substantially constant bus voltage — within ±3 to 5%. It sometimes is done with load-ratio control, generally built into the primary transformer to change taps under load. There are usually 16 steps above and 16 below rated secondary voltage. In some cases, it may prove economical to regulate specific loads instead of voltage for entire plant. This decision depends on voltage limits of supply and required regulation of the specific loads.

Figure cost of load-ratio control at roughly $2.75 per kva of transformer capacity for loads in the 10,000-kva range. Engineers now give more thought to selecting voltage control when designing the primary substation, rather than later at greater cost. Many feel it is justified in nearly every installation where voltages above 15 kv are stepped down to the 2.4 to 13.8 range. Control can be set to hold voltage constant or to raise it slightly as load increases, to compensate for drop in plant system.

outage expectancy based on past experience in your area. Underground cable generally fares better than overhead, but faults often take longer to find and fix. Faults on overhead lines are often temporary; can be cleared readily.

Protection starts with pinning down available short-circuit kva the utility can supply. Check if projected utility interconnections will increase this in the future.

. . . *feeders required, voltage*

economic study. Rates are often more favorable where user owns substation. But initial cost and maintenance may offset this. Many large automotive plants set out, where possible, to buy at utilization voltage, usually 13.8 kv. Other industrials angle for ownership because they want some control of operating reliability. But remember, if you own, you need manpower versed in high voltage.

Voltage chart to left isn't a rule, but it's based on good practice today. Note that 4.16 kv is sometimes economical even to 20,000 kva, but 13.8 opens the road to future plant expansion.

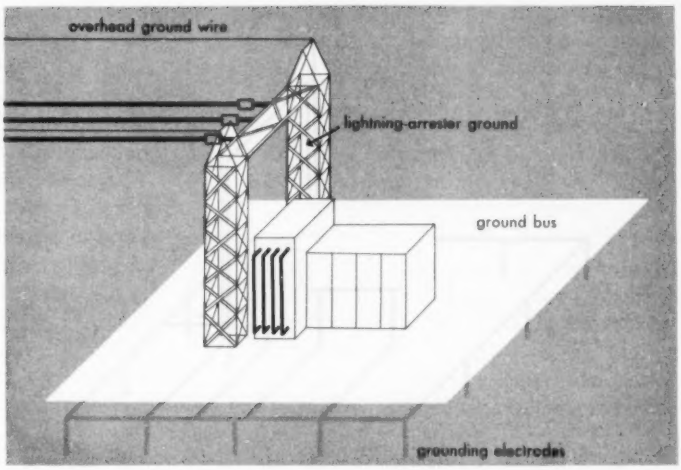
. . . *than "assembled" stations*

stations, where three single-phase units may be best choice. They compare availability problem when replacing a large 3-phase unit against continuing operation with two singles open-delta.

For overhead structures, look into use of aluminum, especially where corrosive atmospheres may cut through galvanized steel. When steel coating is gone, painting must start. This usually calls for killing all or part of substation and forms just another maintenance headache. In a few industries aluminum may not stand up; some chemical and petroleum plants reported trouble.

. . . *hold down voltage swings*

What's answer where supply is below 15 kv and carried directly to secondary unit substations? Load-ratio control in each secondary substation is generally uneconomical and often impractical. The solution is either *step voltage regulators* or *induction voltage regulators* in the primary supply. Their standard regulating range is ±10%. Can you save by hooking two induction regulators open-delta? Dollarwise, yes, but open-delta connection creates unbalanced voltage that may affect heating in fully loaded polyphase induction motors. Best practice avoids open-delta in favor of straight 3-phase regulation.



Plant safety needs good equipment grounding

Equipment grounding is important in primary substation design as well as throughout entire distribution system. It means connecting to ground all noncurrent-carrying metal parts: conduit, raceways, transformer cases, switchgear enclosures.

Prime object is to limit voltage between these metal parts and earth to a safe value under all operating conditions. Three components are used: *Grounding electrode* is a conductor embedded in the earth. *Ground bus* is a network that ties solidly to grounding electrodes. *Grounding conductor* connects equipment and wiring enclosures to the ground bus.

Ground bus should surround building or structure. Grounding electrodes should connect to bus at two or more points. With a double path to earth, a single broken tie won't open the connection. Size of ground bus is based on how much current may flow through it and for how long. For mechanical strength, aside from current-carrying capacity, keep ground bus No. 2 awg, or larger. Modern practice may dictate cable sizes to one million cm for a sound equi-potential grounding scheme.

Local grounding connections for lightning arresters are made by driving rods into earth near arresters. In addition, tie lightning-arrester conductor to common station ground bus.

Where it's exposed to possible mechanical injury, ground bus should be protected, generally by conduit. Connect both ends of conduit to ground bus to avoid inductive effect.

New portable welding device offers a promising way of joining grounding electrodes, bus and conductors (POWER, March, 1953, pp 123-125). Basic elements are powdered metal, firing charge, small crucible. Result is a high-current-capacity joint.

General Pointers: Equipment frames are considered grounded if they're bolted or welded to properly grounded structural steel. Rigid conduit systems by themselves aren't usually considered good grounding connections, but NEC accepts at 600 v, or less. A grounding connection run inside conduit or raceway through which power flows must be insulated, equal in size to largest line conductor but generally not larger than No. 4.

3 supply protection

The utility usually selects protective equipment when it supplies power, except when the customer owns and operates the primary substation. Proper protection of plant generators, particularly against short circuits, is always the power engineer's job.

Today's generators have protective devices that (1) cut down burning of iron and insulation on an internal fault (2) prevent dangerous heating of generator from any prolonged short circuit.

Generator short-circuit devices fall into three classes. *Differential* relays compare currents in opposite ends of generator phase windings, operate when current going in doesn't match that coming out. Essentially independent of load and fault-current magnitude, these relays are quite sensitive.

Overcurrent protectors operate when current exceeds preset amount. These include fuses, direct-acting trip coils and straight overcurrent relays. They must trip fast on shorts but not act on permissible overloads. With fuses, instantaneous trips and relays, current magnitude alone fixes when and how fast device operates. Time-delay relays and trips have mechanically adjustable operating speed.

Voltage-restrained relays measure current and voltage to determine when and how fast to operate.

General agreement prevails that: (1) Induction overcurrent relays and air breakers with direct-acting trips often fail to give selective short-circuit protection because of decrement of generator short-circuit current. (2) Overcurrent relays with voltage restraint or equivalent can be incorporated to permit coordination with feeder breakers.

Voltage and current relaying both play part in today's generator fault protection

Where neutrals of low-voltage generators (under 600 v) are to be grounded, current-limiting reactors hold line-to-ground faults to size of 3-phase fault currents. General practice on higher-voltage generators (2300 v and above) is to ground the neutral through a resistor. In this case, ground current is limited to a still lower value but not less than rating of largest ct in the circuit, to insure satisfactory relaying. This limitation minimizes damage during short circuit yet maintains advantage of a grounded-neutral system.

Short-Circuit Protection. Even with the above grounding practice, there still remains the problem of getting adequate short-circuit protection *where current magnitude alone* is depended on for operation. The reason: By the time we want the generator breaker to operate, there may not be enough difference between fault current and permissible short-time overload current to insure positive operation without running risk of false operation. And the breaker still must be tripped to break possible arc at the fault point even though current magnitude isn't excessive.

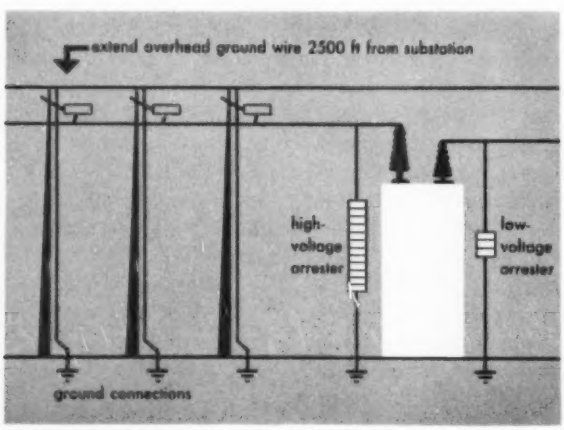
Years back, generators were often operated without protection against external faults other than feeder overcurrent relaying and differential protection around the main bus. Desiring to avoid shutting down generators if at all possible, some utilities still follow this practice (POWER, April 1951, pp 94, 95). Station operators are expected to spot trouble and take steps to clear the fault. This practice was born of the fact that no device was available that could trip the generator breaker on a sustained fault without running the risk of unnecessary shutdowns because of what might be called "normal" surges.

New Practice. This approach is changing since the advent of the overcurrent relay with voltage restraint. This relay can, in effect, size up a given current and decide whether it is a permissible overload or a fault. Sensing ability of the relay comes from taking stock of voltage at the time overcurrent flows. When voltage is normal or close to it, overcurrent is a normal surge. And voltage coil keeps relay from operating. But as voltage goes lower, approaching zero for a solid 3-phase short, the current coil trips the generator breaker.

Some manufacturers recommend such protection for all industrial generators of 2300 v and above. Actually, the scheme is just as desirable on lower voltages but cost often rules it out.

Direct-Acting Trips. Since we're speaking of small machines, why can't direct-acting trip coils of low-voltage breakers be used for short-circuit protection, at least at 600 v and below? They are used. But don't depend on them as sole means of generator protection. They're not in the same league with overcurrent relays since they often can't distinguish between permissible overload and fault current.

Overhead grounding lines help back up lightning arresters in primary substations



If there's overcurrent protection on incoming lines and plant primary feeders, protection of transformer is main item at the primary substation. Transformer windings should be guarded against: (1) surge voltage or lightning (2) overload.

Transformer-winding insulation can be stressed to voltages higher than normal as a result of lightning striking overhead lines or of surges from switching. Practical way to limit such peaks (not new) is with lightning arresters or spark-over gaps between line and ground. Surge current has a low-impedance path to ground when gap breaks down.

But arrester must not break down at normal voltages. And transformer insulation must stand up under voltage surges permitted by the arrester. Today, operating portion of arresters is a ceramic material, able to act as an insulator at one voltage and as a good conductor at a higher voltage.

The arrester has limitations; it often can't handle a direct strike. Hence the overhead ground wire. Grounded overhead line is about the best way to divert any direct strikes.

II

carrying electricity to the job

1 **Which System?** Modern load-center idea is applied many ways. Most widely used system is the simple radial, but others may fit your needs better. Trend is to neutral grounding, higher voltage.

2 **Distribution Components.** Packaged unit substations are economical, flexible. Askarel and dry-type transformers gain ground. Check into new armored high-voltage cables, aluminum conductors.

3 **Circuit Interruption.** In today's plants, interrupting capacity grows ever more important. Air breakers now handle most jobs. New high-rupturing-capacity fuses offer interesting possibilities.

Like leprosy, high voltage was held at a distance in yesterday's plants. Typically, utility feed came into a large primary substation outside the plant proper. The substation housed three large single-phase transformers and a maze of secondary breakers feeding the many loads throughout the plant.

In event of a transformer fault, use of three single-phase units allowed cutting out a faulty one and connecting the two remaining transformers open-delta. In some cases, a spare single-phase unit was kept for just such emergencies.

High voltage has now moved indoors. More dependable equipment, greater degree of safety enclosure, better engineering know-how made this possible.

Main feature of this evolution is the shifting of the point where voltage is lowered to secondary level. Instead of being done at one point outside the plant, it's done at many unit substations near load centers in the plant. There's still a primary substation but, unless utility voltage is over 15 kv, it's now mainly a switching point. Cables from the primary substation still run throughout the plant, but there are fewer of them and they're smaller because they operate at higher voltage.

But there's more to modern distribution than moving high voltage indoors. This was a major step but for top results it must be carried to its logical conclusion by choice of proper circuit arrangement. **Available systems,** some 11 in number, range from simple radial to more complex network hookups. All have their place, but the survey on which this report is based shows that three of these find widest use, by far. So discussion here is limited to simple radial, selective-radial and network systems.

Today's load-center distribution system shows lower cost than . . .

Regardless of the reliability built into production equipment, entire operation of your plant depends on uninterrupted supply of electic power to the many motors, lamps, furnaces, welders, etc. Thus, speaking broadly, function of your electrical distribution system is to receive power at one or more bulk-supply points and deliver it dependably to every electrical device in the plant.

Comparative Costs. Unlike many other advanced methods, carrying high voltage to heart of the plant actually costs less than distributing at low voltage. To drive this point home, let's consider the case illustrated by the relative-cost chart, upper right on facing page. Figures are based on a 250,000-sq-ft single-floor plant. Old method of supply would have a one-line diagram like that at left of illustration. A single large substation would be located outside the building, and long low-voltage feeders would string through the plant to serve the loads. With a 13.2-kv incoming line, this power system, right through to final plug-in bus duct, would cost about $100,000 installed.

Load-Center Savings. A modern load-center system using packaged secondary unit substations (see diagram, p 89), would cost about $83,000 for the same plant. This is a saving of $17,000, or 17%. Secondary substation system has about 3000-kva capacity to allow for diversity, but these substations cost only about as much as a 2500-kva outdoor substation assembled on the job.

Major saving comes in cable cost, as chart shows. This brings out the importance of looking at the over-all system in any economic study. A change in one part may have a significant bearing on cost of another part. Here, high voltage on feeders makes them smaller.

In this case, two primary feeders were selected for the load-center system. This further increases system selectivity compared with old-style layout. Here, by selectivity we mean being able to maintain part of the load in an emergency such as a primary cable or transformer failure. Although sketch doesn't show it, use of two primary feeders requires more circuit-interrupting equipment. In spite of this, switchgear cost runs about the same for either system.

Then, while transformer costs are greater in the load-center system, secondary switchgear cost is materially reduced, since only 15,000-amp interrupting-rating feeder breakers (in cascade) are needed for small 750-kva secondary substations. With old low-voltage distribution scheme, 50,000-amp feeder breakers (in cascade) would be needed for the large 2500-kva substation.

Additional Savings. Average load-center system shows lower losses than older low-voltage distribution. As plant grows, extra savings result from load-center system's greater flexibility in handling new loads in existing buildings, or expansion.

We can illustrate this by supposing that the plant we've been talking about is extended so as to need about 1200 kva more. If we add this transformer capacity to the old-style low-voltage system, short-circuit currents on *all* previously installed feeder breakers are increased. Possible short-circuit duty would be increased so much that breakers would be inadequate, and there'd be an immediate expansion bottleneck.

Easy Expansion. Contrast foregoing with expansion of a load-center system. Here we merely extend the two high-voltage feeders and add two new unit substations. Short-circuit values aren't increased at any existing unit substations.

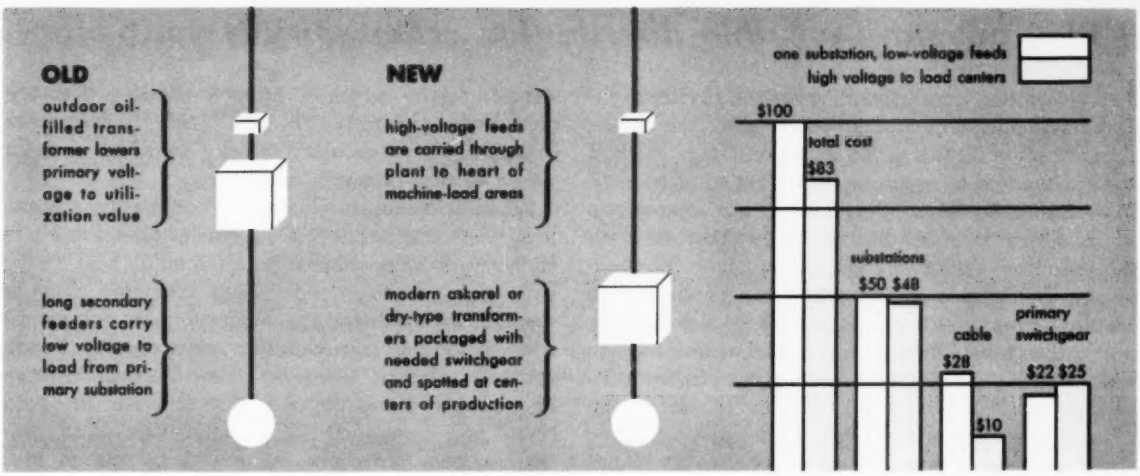
But suppose we had put extra transformer capacity in the old-style low-voltage system, in anticipation of load growth. Load-center system still proves less costly to expand, because its capacity can be built up in small units as load grows. Thus power-system and plant growth are closely coordinated. With the older system, a large capital investment must be made initially in a big single substation. Secondary feeders are added as needed until limit of substation capacity is reached. Then another substation is built at great expense. If load doesn't grow, investment is wasted.

In applying load-center methods, however, initial investment can be lower because you need only install capacity for present loads plus a small reserve.

Handling Large Loads. In the following four pages we'll talk about circuit arrangements now in use and some of the thinking behind plant decisions on adoption of one or another system. But before we get to that, there are some general thoughts which apply regardless of the specific system used, in particular the question of handling large loads.

Typical would be large motors, say above 200 hp. Such units can often be served more economically at voltages above 600. Thus they're out of range of secondary side of regular secondary unit substations. If primary voltage is suitable, they may be served directly.

Direct from Primary. For example, motors above 200 hp may feed directly from a 2400-v primary system. Likewise, motors above, say, 250 hp, can be served from 4160-v systems and those over 1000 hp from 6900-v. Motors above 2000 hp may be supplied at 11.0 to 13.8 kv.



. . . low-voltage layout, and flexibility makes its expansion easier

But you'll still run into cases where there are loads that can't be fed properly from either primary or secondary. There are two possible answers. If, say, you have one or two motors too large for secondary voltage (480-v systems) and too small for primary voltage, best bet is to feed such motors from primary through separate transformers.

Transformers at Load. Let's look at an example—an 800-hp motor in a plant with 13.8-kv primary. Most economical answer would probably be to serve the motor from the 13.8-kv system through a stepdown transformer with a secondary voltage of the order of 2300 v.

On the other hand, let's say you have concentrated groups of large motors and an electric furnace. You'd normally feed them direct at primary voltage but you can't because it's too high—let's say 13.8, 34.5, or even 69 kv if it's a very large plant. With exception of 13.8, these voltages would be too high to apply to any motors, and 13.8 is too high for most.

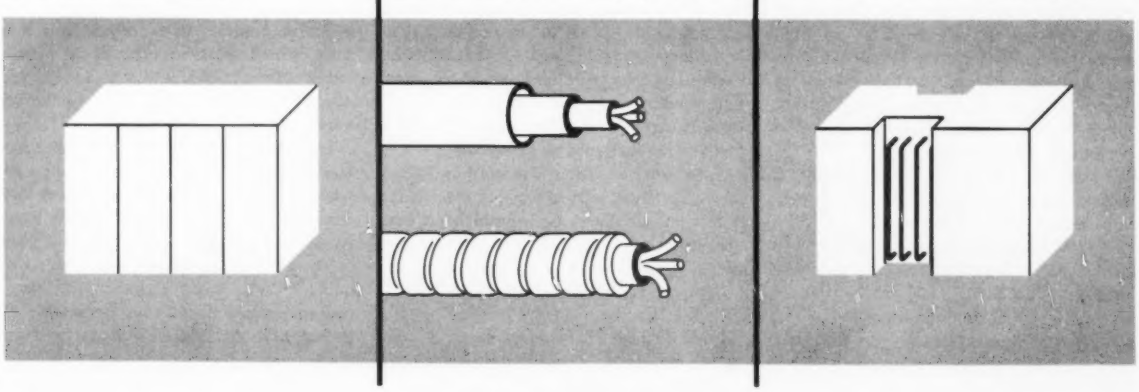
Medium-Voltage Substation. The answer in this case lies in an adaptation of the load-center idea. Supply big loads or groups of large motors from a separate unit substation having a secondary voltage in the range between 2.4 and 13.8 kv. A typical case is found in paper mills, where primary voltage is often 13.8 kv. Here large motors are generally supplied at 2.4 kv through a 13.8/2.4-kv substation. Smaller motors operate at 480 v.

Here are the basic elements of a modern load-center system

switchgear Today, switchgear is often the major equipment item in the primary substation where incoming feeder voltage is less than 15 kv. Circuit breakers are the usual interrupting means, operated through induction relays and ct's. But load-interrupter switches and high-voltage power fuses may be used. Either way, packaging is the theme, rather than field assembly of the separate components.

feeders For connecting primary and secondary substations, cable in conduit is meeting tough competition since advent of armored cable. This new version of low-voltage armored cable licks cost of conduit installation and cable pulling. It offers increased mechanical protection. Simple mechanical methods of splicing and terminating have been developed to eliminate the need for costly lead wiping of joints.

substations Heart of modern system is the secondary unit substation. It has three parts: incoming ac-line section, transformer, secondary switching section. Incoming line may have breakers, junction boxes, interrupter switches. Transformer may be oil, askarel, ventilated or sealed dry type. Secondary section may have drawout air circuit breakers, molded-case breakers or some form of motor control incorporated.



Which of many possible distribution schemes suits your plant?

Before selecting your system, review many arrangements possible with modern load-center technique. Commonest is *simple radial* using one or more high voltage feeders to secondary unit substations.

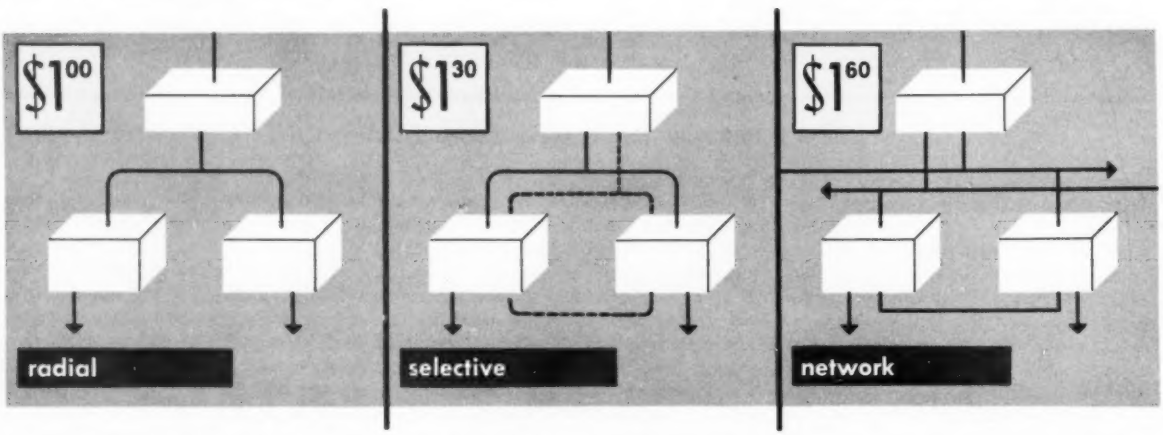
Other Radial Systems. *Loop-primary* has closed loop on high-tension side, disconnect switches in each substation to isolate any segment of loop. *Banked-secondary radial* uses primary loop with connection (through circuit breakers) on secondary side of adjacent substations. *Primary selective radial* has, in effect, a double feed to each secondary substation. Selector switch before transformer at each unit chooses one feed or the other. *Secondary selective* radial may use same idea of duplicate supply but with a bus-tie setup on secondary side of each sub.

Network Systems. *Simple network* is automatic secondary network first used about 30 yr ago. Here a primary feeder or transformer failure won't cause even momentary interruption of any load, nor is switching needed to restore service. In *simple spot-network*, emergency capacity is provided by making a spare primary cable and transformer available at each load center instead of tieing them together in a secondary loop. *Primary-selective* offers lowest cost network for plants or load areas requiring two or three primary feeders. *Primary selective spot-network* has each transformer equipped with a primary selector switch to connect either of two primary feeders.

When it comes to choosing your plant's system, look first at *reliability*. Can system be adapted to changing load conditions with minimum cost?

To check *voltage regulation*, take into account changes in load voltage, uniformity of voltage at various load points, changes resulting from loads suddenly applied. Consider over-all *efficiency* from bulk-supply points to utilization devices, for both light- and heavy-load conditions. *Operation and maintenance costs* are influenced by nature and amount of equipment, ability to test, inspect and maintain with minimum interruption. *Initial investment* figure should include complete installed cost.

When you consider array of possible arrangements, you see they break down to three broad types — radial, selective-radial, and network (diagrammed below). Don't be led too far astray by "price tags" on sketches. They're simple approximations of best available mean values. Particularly for selective and network systems they merely indicate middle-of-road values for costs that actually vary widely.



Here, for lowest first cost and least cable, we get what proves to be adequate reliability for most industries. Low first cost derives from the fact there's no duplication of equipment—one primary feeder and one transformer serves a given secondary bus.

In the simple radial arrangement, if substation capacity is sufficient to provide about 10-15 volt-amp per sq ft of plant floor area, experience shows it will adequately care for almost any diversity resulting from shifting of loads.

Simple radial systems have found application in almost every type of plant, meeting the service requirements of exacting and critical processes.

Selective-radial systems have another available source for emergencies, either on primary or secondary side of unit substation. *Primary selective* system uses two feeders to each substation, either able to supply load. Switching to select desired feeder must be provided.

Secondary selective system has many forms but basically it's a simple radial with normally open tie breaker between substation pairs. This makes emergency power available at secondary buses with minimum additional equipment. Added complication over radial is slight since ties are normally open, transformers aren't paralleled. This holds down possible short-circuit currents.

In network systems: (1) transformer secondaries connect in a ring bus or loop from which short radial circuits feed loads (2) primary feeds have enough capacity so entire system can be carried when any one feed is out.

Transformer secondary leads have *network protectors*. Relays close them only when voltage conditions are such that associated transformer will supply loads to secondary loop, and automatically open them when power flows from secondary loop to transformer. Network protectors guard loop and loads fed from it against transformer and primary-feeder faults by disconnecting defective units in loop when a backfeed occurs.

Most plants meet needs best with low-cost simple radial system

Simple radial systems have gained widest acceptance in today's industrial plants. Reasons: maximum simplicity, good reliability, lowest first cost.

Prior to 1940, "simple radial" meant feeding entire plant load through a single primary substation using one or more low-voltage buses at the incoming substation. This layout has largely been replaced with the post-1940 simple radial using high-voltage primary feeders and secondary substations. Today, some small plants, under about 1000 kva, still select the older-type system and they may be economically justified as long as the plant stays small. But they're strapped for easy expansion.

In "new" radial, if enough substation capacity is installed to give about 10 to 15 volt-amp per sq ft of manufacturing area, system will generally be able to ride through most shifts in load areas that come from process changes.

How reliable is the simple radial? Answer lies with primary cables and secondary substation transformers. One manufacturer offers an average figure of one askarel transformer failure per 2500 transformer-years. Same source figures primary feeder faults average about one per mile per 100 service years. Conclusion: Today's equipment boasts enviably low fault expectancy.

Remember, however, that average figures may not hold true for you. Think how a transformer failure or cable outage would affect your plant, what it would cost in production losses. This may lead to adopting a more complex system if you can justify added cost.

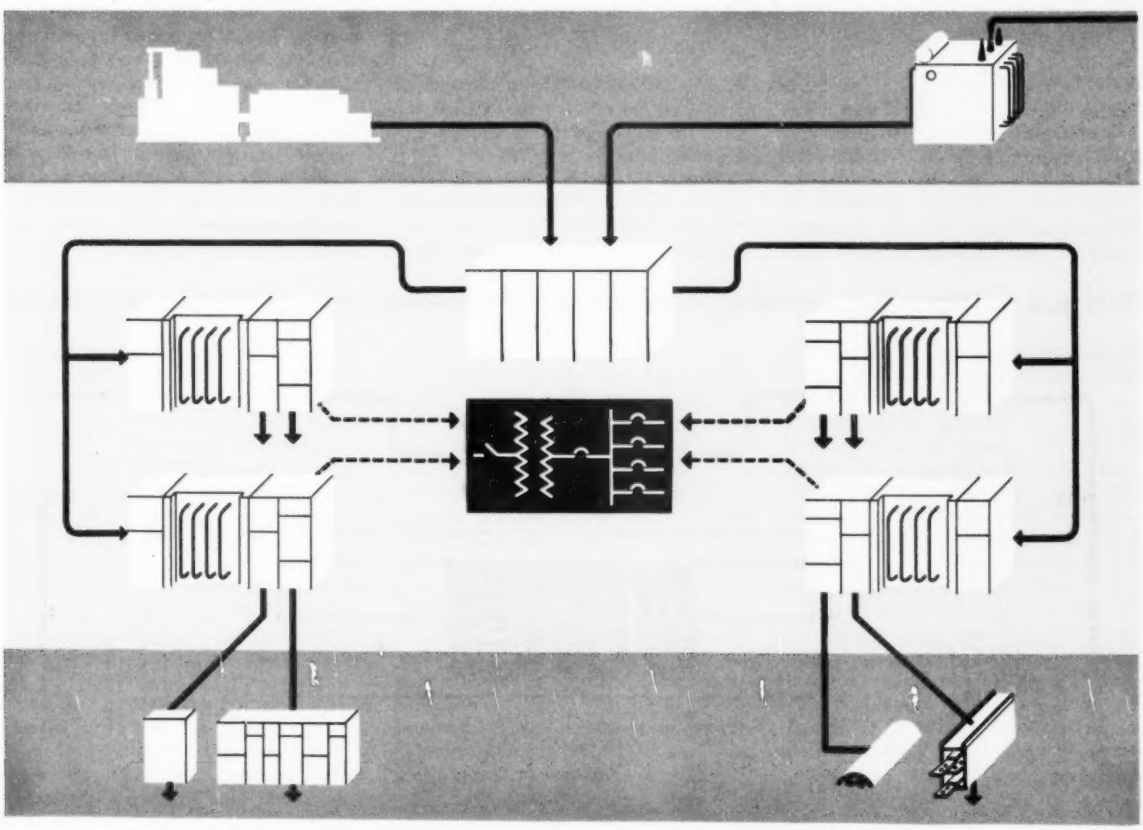
For top economy with a simple radial system, connect a number of secondary substations to each primary feeder. But balance out this saving against possibility of a cable fault knocking out all substations on one feeder. In a small plant, that might mean half or all the plant would go out. Such an outage may be of relatively long duration since it waits on repair of the cable.

A transformer fault, however unlikely, would interrupt service to area fed by that secondary substation. Service can be restored to remainder of plant after disconnecting faulty unit.

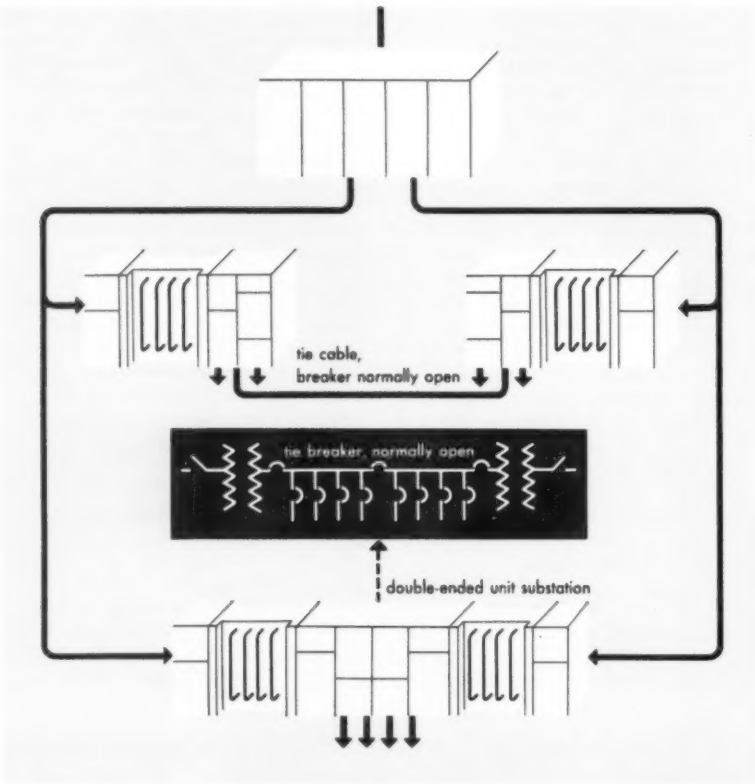
Good points of radial systems justify its wide use. Power engineers like its simplicity, an important factor in plant safety since possibility of switching mistakes, especially during an emergency, are cut to a bare minimum. Like most load-center systems, it can be expanded readily by simply extending the high-voltage feed or adding other feeders. Right now the system serves well in a wide variety of plants, some with exacting and critical load demands.

Service continuity can be improved, while sticking to the simple radial system, by reducing number of transformers tapped into each feeder. This holds down area affected if a primary cable fails but sharply increases initial cable cost. It also means more primary-feeder breakers. You must juggle cost of increasing reliability by this means against the values gained and against cost of selective or network system.

Where there's pressing need for further system reliability it generally can't be met by simply adding primary feeders—there's an economic limit. When that limit is reached, consider a selective-secondary radial system. The selective systems, both secondary and primary, are outlined on the following pages. These are improved variations on the basic radial scheme. The network arrangement stands by itself, offering further unique advantages.



Secondary-selective scheme ups reliability at little added cost



At only slight increase in cost over simple radial systems, secondary selective offers somewhat more flexibility and greater reliability. Really a simple radial with normally open tie breakers between pairs of single substations or double-ended ones, it gives emergency power at every important secondary bus with minimum additional equipment. Secondary selective finds widest use today in larger plants of all types — chemical, paper, steel, drug, etc.

When this system is properly engineered, any part from source through secondary-substation main secondary breakers can fail or be taken out of service, yet power can be made available on every secondary bus by merely opening proper substation main breaker and closing proper tie breaker. Because ties are normally open, operating complication is increased only slightly.

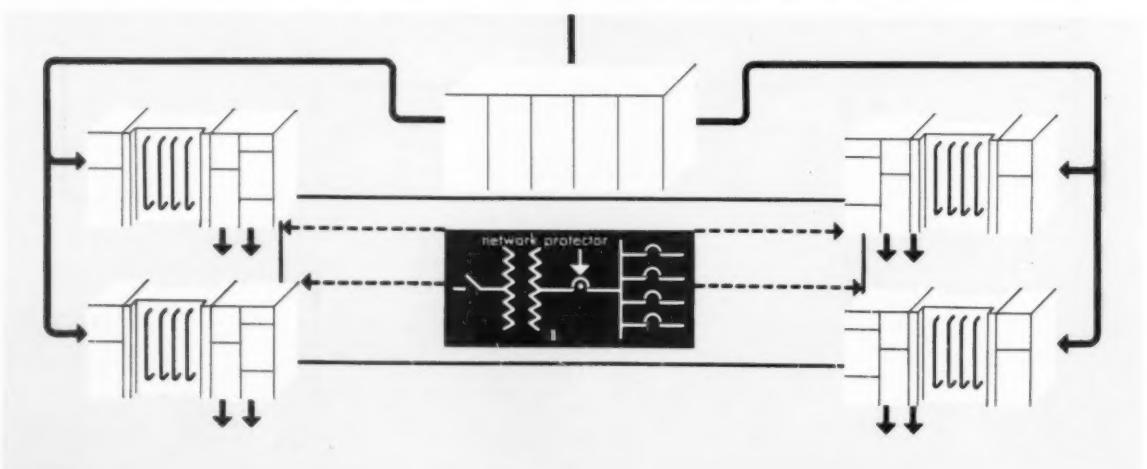
To take full advantage of this scheme, you must plan to drop all nonessential load when a transformer or feeder is out. If this is difficult, specify extra capacity in each transformer (using fans in an emergency), or a spare that fits all subs.

Spot Secondary Selective. One of several arrangements, this has pairs of single substations (or double-ended units) located side-by-side with a tie bus. This is simple and compact. All interconnection and switching is at one spot for any one pair. This is usually lower in cost than other forms using distributed single substations. With two single-ended units, extra secondary circuits can be added easily.

Distributed Secondary Selective. In this form, each substation serves a smaller load area. This reduces secondary feeder cable but savings may be partially offset by extra tie cable needed. Many engineers prefer this plan for a new plant — as load grows another transformer can be added in each substation to form a spot secondary selective, allowing 100% growth in any area.

How about shifts in load caused by changes in product or processes? In such plants, plug-in bus duct is commonly used for distribution to machines, and it usually provides enough flexibility for load shifts. For more extensive shifts, the separation point in the plant bus duct is changed to reduce load on one substation and add it to another.

Network systems deliver uninterrupted secondary power even if a primary feeder or . . .



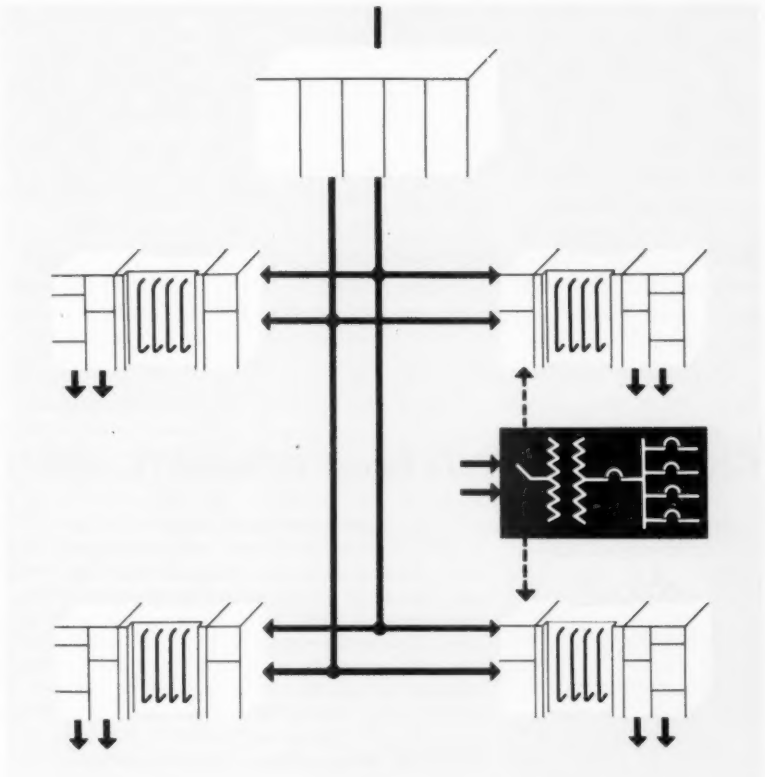
Primary-selective, another radial modification, fits some needs

Here two primary feeders (each big enough for entire load areas) go to each substation; with proper switching equipment on incoming side either can be used to supply power. This switching, plus extra primary cable, usually increases feeder costs compared with simple-radial or secondary-selective. In normal operation, half of transformers connect to each of the two feeders.

Handling Faults. If fault occurs in a transformer, its associated primary breaker opens and interrupts service to half load area. Where load-interrupter switches are used instead of breakers at transformer, unit is disconnected from system by opening transformer interrupter switch. Reclosing primary feeder breaker then restores service to rest of load area. But service to area normally fed from faulty transformer can't be restored until defective unit is repaired or replaced. Without secondary ties, there's no provision for service continuity if a transformer fails, although this system takes care of feeder failures.

With adequate breakers for transfer, this system is as safe as any and where cable failures, for one reason or another, are greater than average, service reliability can be increased. Where disconnect switches are used for transfer instead of breakers, there's always a chance that transfer switch may be operated without first tripping primary breakers. In case of an electrical failure, this transfer would be hazardous, might cause loss of both primary feeders.

Interrupter Switches. Some engineers will select two single-throw instead of one double-throw to improve reliability and make maintenance easier and safer.



Often, where a double-throw primary selector switch is used, cable terminations are so close it may be unsafe to work on one cable with other energized.

Taking all into consideration, power engineers today lean to either simple-radial or secondary-selective systems, rather than primary-selective, except in those instances where the number of cable failures is far above average.

Some combine advantages of primary- and secondary-selectives by using primary-selective and providing some sort of emergency secondary tie (normally open) between stations. This overcomes big disadvantage of primary selective.

. . . *a secondary transformer fails. If top reliability is needed, extra cost is justified*

Network systems are designed to give uninterrupted secondary power even if a primary distribution feeder or secondary substation transformer fails. This is the most costly of available systems, but many power engineers feel the top reliability warrants added cost.

Note in sketch that all secondary substations have their low-voltage sides tied together in a loop or network. In secondary-network shown, high-voltage feeds are set up like those in straight-radial or secondary-selective hookups. Big difference is that each transformer feeds into secondary load network through a network protector. As load is added anywhere on secondary it is shared by system collectively. Setup also permits taking out any transformer or primary feeder for maintenance without interrupting service to any load area.

Secondary network loop provides for service continuity in any emergency plus ringing in the load diversity angle. Load is equalized on all transformers feeding the network. This network tie-in generally improves voltage conditions, favoring feeding power and light from same load buses. Holding voltage up is of major importance, especially during large-motor startups.

Network Protector. When a transformer or primary feeder faults, network protector and proper primary breaker trip, disconnecting faulty section from system. Meanwhile service on secondary continues uninterrupted, since remaining secondary substations pick up added load through network tie.

Network protectors are special air breakers controlled by network relays. And since network relay operates only when there is a reverse power flow — from secondary network to secondary side of any transformer — only network protectors associated with faulty feeder-transformer unit open. Thus load continues to be suppled over remaining feeders and associated transformers, without interruption. No manual switching is needed, as with selective schemes.

When considering any network arrangement, look closely into available short-circuit currents on secondary buses. Since all transformers in secondary unit substations are paralleled, additional available short-circuit currents may call for breakers with greater interrupting capacity than those for a more simple system.

There are three camps on this matter of neutral grounding. First, and growing, are those all for it. Second, there's a group against it. They cite better service continuity they feel is inherent in an ungrounded system. Third are engineers who have lived with an ungrounded system but are realizing the advantages of grounding. On a modernization program they'll stick to ungrounded neutrals but will leave the door open for a later switch by specifying Y-connected transformers.

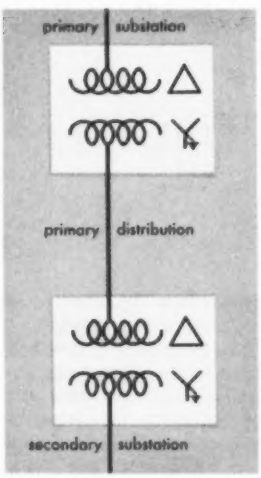
Sound engineering plus solid field experience backs today's swing to neutral grounding. Most popular method grounds neutral of a Y-connected transformer or generator. Few ground corner or center of phase on 3-phase delta.

In the ungrounded camp there are those who diligently search out each ground as it occurs. They aim to keep the system completely free of accidental grounds. Others still take the shortsighted approach of keeping the system operating with one phase accidentally grounded. They depend on overcurrent protection to clear the circuit if another phase grounds; in effect, a phase-to-phase short.

If you ground neutrals:

(1) Ground at each voltage level; only at source. (2) Leave no part ungrounded. Ground each major bus section if you can separate them. (3) Neutral grounding needs three overcurrent devices, one in each phase. (4) Most systems need only two overload relays for motor running protection whether or not it's neutral grounded. Some need three. Check this. (5) If primary voltage is between 2.4 and 13.8 kv, consider resistance grounding.

Grounded neutrals boost reliability, safety, equipment protection



On Y-grounded low-voltage systems, as on the secondary side of load-center unit substations, line-to-neutral calculated voltage is maximum met either in normal operation or with a ground on one phase. In ungrounded systems, two ungrounded phases are at line-to-line potential measured to third phase when it accidentally grounds. And first fault doesn't automatically clear. If fault occurs on another phase, there's a phase-to-phase short.

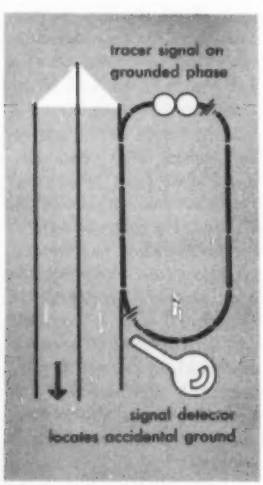
Operating Hazards. When different phases of an ungrounded system accidentally ground in near-by machines, a fire hazard may result. Current path between grounds can include greasy shavings or other material that could be ignited by localized heating or sparks. Impedance of path is high, so current flow may be enough to start a fire but won't blow fuses or trip breakers.

On ungrounded systems, "sputtering" grounds can cause overvoltages. Circuit formed between system capacitance (mainly cables) and system inductive reactance builds up voltage between phases and ground to several times normal line-to-line. In cases on record such sputtering grounds led to multiple motor faults until located and cleared.

Overvoltages can stem from sources other than sputtering grounds — lightning, contact with higher system voltages, resonance in series inductive-capacitive circuits (POWER, Aug. 1952, pp 90-92). But a grounded neutral will hold phase-to-neutral voltage constant.

Equipment Protection. Grounded systems offer better equipment protection. Relays will detect grounds and clear circuit before arcing develops into phase-to-phase faults. On primary voltages of, say, 2.4 to 13.8 kv, resistance grounding is often used to hold down burning at ground point, reduce explosive effects.

If critical loads justify ungrounded operation, here's how you make the best of it



With so many arguments in favor of grounded neutrals, how do today's ungrounded systems manage? Two things are needed: (1) topnotch maintenance to keep circuit insulations in good shape (2) some practical method of quickly locating grounds before they develop into phase-to-phase faults.

That's just about the way many first-rate power engineers handle the problem. They fully realize disadvantages of an ungrounded system. But they believe that, because of critical nature of their loads, demand for continuous service justifies an ungrounded system.

Lamp-Detectors. Where a simple lamp-detector is used on an ungrounded system it indicates only that a ground does or does not exist. If there is a ground it doesn't tell where. The only available way to find which branch circuit is causing the trouble is to trip the circuit breakers one after another until the lamp-detector shows the fault is cleared.

This procedure, of course, isn't practical in a modern plant. In lieu of it we now have trouble-sniffing instruments that track down point of fault on an ungrounded system without shutting off power. See sketch, *left*.

Impulse-Detectors. A modern ground-detector impulse unit clamps to ungrounded phases at the main bus. A signal current is superimposed on the grounded line all the way down to the trouble point. Then, with a sensitive induction-type impulse receiver, the signal is traced, even through metal-clad switchgear and conduit on the grounded line. The portable detector unit will even pick up an impulse as small as half an ampere. So it readily indicates the point at which signal leaves the power line and enters ground — the fault point. For details of this ground detection procedure, see POWER, May 1952, pp 132, 133.

Voltages continue to climb. Power engineers and makers of equipment come closer to agreeing on "ideal" voltages, so we move toward fewer levels.

Selecting Voltages. Plant safety and local codes enter but three main factors are: load size, distance and equipment ratings. Bigger loads and longer distances point to higher voltages. And, of course, voltage ratings of using equipment must match feeds.

Power engineers no longer consider 4.16 or 13.8 kv too dangerous to have around. Greater safety of today's equipment, both in insulation and mechanical enclosure, makes high voltage nothing to fear.

Primary Voltage. Here higher levels mean lower cost, greater flexibility and expansion margin. Savings increase as plants spread out and loads get bigger.

On the secondary side, apparent advantages of higher voltage point to making it as high as possible, up to limit of 600 v. Actually, 480 v is becoming the byword for new load areas because of ready availability of utilization equipment for it.

Higher voltage levels offer economies, flexibility for expansion

Each of many voltages available for primary distribution — 2.4, 4.16, 13.8 and 6.9 kv — has its place. But today's thinking points to two: 4.16 kv for plants having a supply transformer and/or generating capacity of 10,000 kva, or less, and 13.8 kv where there's a supply transformer and/or generating capacity of 20,000 kva, or more. So for range between, either of two voltages may be most economical. In choosing, don't forget your plant will probably grow. While 4.16 kv might possibly be slightly less expensive now, if plant should require sizable expansion 13.8 kv would be more economical.

2.4 or 4.16 kv? With all factors included — switchgear, motors, starters — costs generally favor 4.16 kv. In addition, there's greater allowance for expansion at 4.16. In small plants (say 2000 kva) differential may be small but in larger plants (up around 15,000 kva) saving can be several dollars per kva for 4.16 kv.

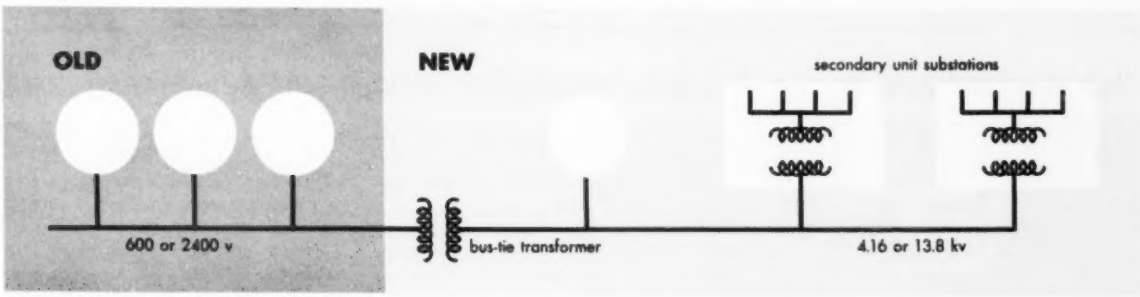
Feeder costs usually dip as voltage rises. Data for a modern armored high-cable primary-feeder layout points to a saving of about $1.00 per circuit kva per 1000 ft, for 4.16 over 2.4 kv. Operating at 13.8 offers an additional saving over 4.16 of about $0.50 per circuit kva per 1000 ft, where individual circuit loads can be kept in the 3000-kva range. Cost of terminating may detract from economy of 13.8 kv if average length of runs is low and there are many small loads or substations per feeder. But more kva can be carried at higher voltage: fewer lines may be needed.

At 4.16 kv, switchgear for a given interrupting capacity costs less than at 2.4. And in a 4.16-kv system, if a 1200-amp breaker is needed, a more expensive 2000-amp job would be required in a 2.4-kv system.

What about expansion? Largest metal-clad breaker for 2.4 kv is 150 mva maximum interrupting rating. For 4.16 kv, maximum is 250 mva. This allows a much larger system without synchronizing buses, current-limiting reactors, or other means of cutting fault current.

Secondary Voltages. Today's practice puts spotlight on 480 v; forward-looking power engineers seldom find good reason for selecting 240 v. Costwise, 240-v systems run higher than 480: heavier current means larger cable, breakers.

It used to be argued that 240 v is required for areas with heavy electric furnace loads. Today most large furnaces can operate directly from 480 v. Even though a sizable portion of load is at 240 v for small furnaces, it's seldom economical to adopt 240 for general distribution. Select 480 and step it down to 240 for specialized loads. Another point favoring 480 v is ease of getting 277 v for plant lighting (see pp 122, 123).



In modernizing, present voltages needn't limit you, higher ones can be worked in

Electrical modernization plans may involve: (1) replacement of some unsafe or obsolete part of the system, with little or no expansion of capacity, or (2) expansion to boost capacity for growing loads. In either case, biggest gain can be made by changing to a load-center system and higher voltage.

Best Approach. Start by laying out a complete ideal power system of type and voltage desired. Plan it as if you were building the entire plant new. Then see what modifications of the plan are needed to use serviceable existing equipment.

From then on, every step should be based on the ideal plan. Too often, power engineers spoil good intentions by letting the existing setup influence future plans too greatly. This is especially bad if the old system isn't right for plant conditions.

Higher Voltage. Always check this when expanding or modernizing an existing system. Converting a low-voltage system to a higher voltage is a simple procedure. As sketch shows, it merely requires addition of a bus-tie transformer between the buses. Then expansion can be to higher voltage as if lower voltage system didn't exist. Old low-voltage and new high-voltage system can be tied in several other ways.

Many plants using a 2.4-kv system are facing expansion, yet want to hold onto 2.4 already installed. This can be done by working in a 13.8-kv system to serve new loads and also areas of 2.4 kv through appropriate transformers.

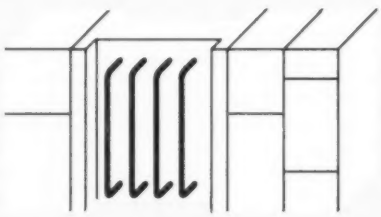
Secondary unit substations, placed close to load centers, take primary distribution voltage, transform it to lower secondary value (usually 480 v today) and, through a system of circuit breakers, start it on its way to nearby load areas. Standard factory-assembled units offer (1) fast delivery, skipping drafting-room time needed with "specials" (2) top interchangeability and flexibility when future changes are necessary (3) quick replacement of any elements damaged during equipment life (4) lower cost than field-assembled substations.

Strive for uniformity in your substations. Group loads so substations of equivalent kva can be used. Aim for interchangeability of transformers and switchgear. Then one spare is spare for all.

Future Growth. Sizable load additions usually call for new substations. But small new loads can often be tacked on existing units, provided spare capacity was incorporated when originally selected. In modern units, switchgear is so designed that complete new feeder sections may be added with ease. During design stage, check that enough floor space is avail-

Single-ended unit substations satisfy the needs of most plants . . .

Incoming section between primary feeder and transformer may have circuit breaker, load-interrupter switch, oil-fuse cutout, selector switch, or a solid connection. Where switches selected interrupt transformer magnetizing current only, a keyed interlock is usually used, tied in with main secondary breaker. Load-interrupter switches are available with or without power fuses for transformer protection. Switch and fuse combination is economical, effective. With two incoming lines, a 3-position selector switch is used. Make sure there's enough space to throw switch without hazard.



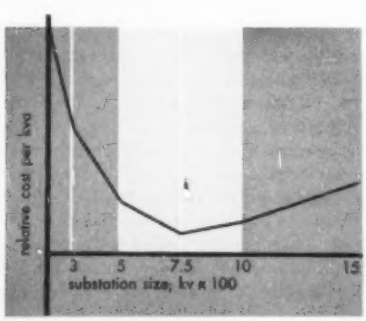
Transformer can be oil-filled, askarel, vented or sealed dry type (pp 96, 97). Askarel offers high impulse strength, can be put indoors or out. Sealed dry type combines some advantages of liquid units (sealed against outside dirt) yet needs no maintenance other than occasional inspection, external cleaning.

Secondary switchgear now makes wide use of drawout breakers. Molded-case breakers can be used with substations up to about 300 kva, have widest use where operation is infrequent and drawout feature is not necessary (lighting substations, for example). Breakers may be manually or electrically operated. Control centers may be used where you want to centralize ac motor starters, lighting panels and associated controls in one spot.

Provide spare breaker position when you want secondary-selective layout. Run cable between this point and bus of nearby substation.

Interrupting capacity of secondary switchgear is important in substation sizing

To arrive at most economical substation size for any plant, study the factors that directly affect installed cost: length and size of both primary and secondary cables, primary voltage, heavy spot loads, required interrupting capacity for secondary switchgear, primary short-circuit protection. Curve, *below*, was prepared on a basis of 480-v secondary distribution, after considering above factors in a typical plant. Curve changes if 208 v is used; economical size then falls around 300 kva.



Substation Costs. For small units, costs climb mainly because of higher transformer cost in smaller kva ratings. At other end of scale, costs climb with bigger units mainly because of greater available short-circuit currents, calling for more expensive secondary switchgear. And since larger subs usually serve larger plants, secondary cable cost mounts fast with station size.

With 13.8 kv on primary feeders, aim for 4000 to 7500 kva per feeder. Then 750-, 1000- and 1500-kva units can usually be applied without individual primary overcurrent protection (NEC, paragraph 4512b). Such protection would be needed with 500-kva substations and same primary voltage and loads.

If primary voltages fall between 2.4 and 4.16 kv, most economical primary feeder loadings are between 1000 and 3000 kva per feeder. In this range, smaller substations can be used without the added primary protection.

Heavy spot loads often justify larger substations. Typical are furnaces, ovens, large welders — these might call for 2000-2500-kva subs at 480 v.

Interrupting Rating. There are three common short-circuit-rating brackets in the low-voltage range: 15,000, 25,000 and 50,000 amp, all rms asymmetrical. Assuming a 480-v secondary, largest sub generally used within 15,000 amp is 300 kva. If 25,000-amp figure isn't to be exceeded, 750 kva would be top practical limit. Where substations larger than 750 kva are used, secondary switchgear generally carries a 50,000-amp interrupting rating. This last requirement alone often dictates two 750-kva substations rather than a single 1500-kva unit.

able to take additional switchgear at low-voltage end of substations. Since breakers in the same interrupting class are interchangeable, you can increase breaker size without structural change.

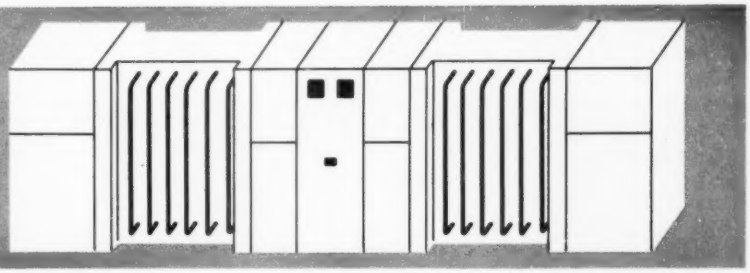
Substation Size. For each plant there is generally an optimum size giving lowest cost per kva. With many small units, more primary cable is required, boosting installed cost. But small units reduce the amount of secondary cable. On the other hand, when substations are large, switchgear and secondary-feeder-cable costs climb.

Location. First determine where the substation would fit best in an ideal situation — indoors or out. Modern practice includes the plant roof as well as space alongside the building in the term "outdoors". Another out-of-the-way spot is in balcony areas. Such location offers savings in valuable floor area and in additional costs of outdoor roof equipment.

Unit substations are available in double-ended designs as well as the familiar single-ended type. Weigh well the economics of double-ended designs before ruling out straight singles across the board.

. . . *double-ended units may prove best bet in concentrated load areas*

Two transformers feed two sections of low-voltage gear with a normally open breaker between. Unit provides service if transformer or incoming line fails



Double-ended substations go hand in hand with secondary-selective and network arrangements. If either of these hookups looks best for your plant, you then need to weigh single against double units. With doubles, maintenance and testing of transformers can be done without service interruption. But they cost more, mainly because of the need for two main secondary breakers and a tie breaker, not necessary with single units. Main secondary breakers are necessarily large to carry full transformer load current.

Where loads are heavily concentrated in one area and the choice is between two economically sized smaller substations and one single large unit, double-ended design may prove best.

Spare Transformer. Some power engineers buy a spare transformer as a replacement for many similar-size units throughout the plant, and stick to single-ended substations. In an emergency, spare can be put to work quickly.

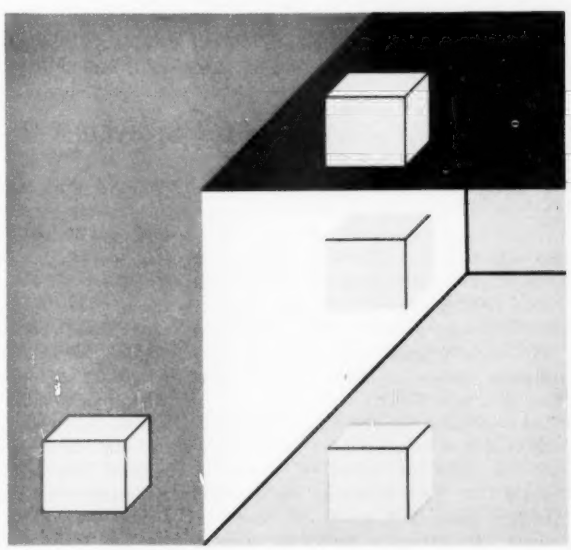
There are times when each transformer of a double-ended unit must be sized to carry total substation load so no load need be dropped if a feeder or single transformer fails. More typically, load diversity and judicious emergency operation are counted on to hold normal rating for both transformers.

Secondary unit substation location affects costs and efficiency of distribution system

building roof This location proves popular where primary distribution is overhead and bus duct is used. Then short secondary runs drop direct to bus duct. Roof location often sidesteps high ambient temperatures, dirt and fumes in plant; it also fits well where load areas change frequently. Remote tripping and closing of breakers is usually needed.

balcony areas Steel structure with expanded-metal or sheet-steel floor is placed high enough so space below is usable, often as a washroom. Balconies keep substations out of normal traffic and, in food plants, out of range of splash from equipment hosing. Substations are also suspended in roof trusses, just above lowest structural members.

floor level Check plant layout for low-value areas indoors at centers of load. Consider, too, putting substation immediately outside. And where buildings are long and narrow, study areas between them if cable runs can be kept short. Avoid spotting all equipment at a single transformer bank; stick to load centers and short secondary runs.



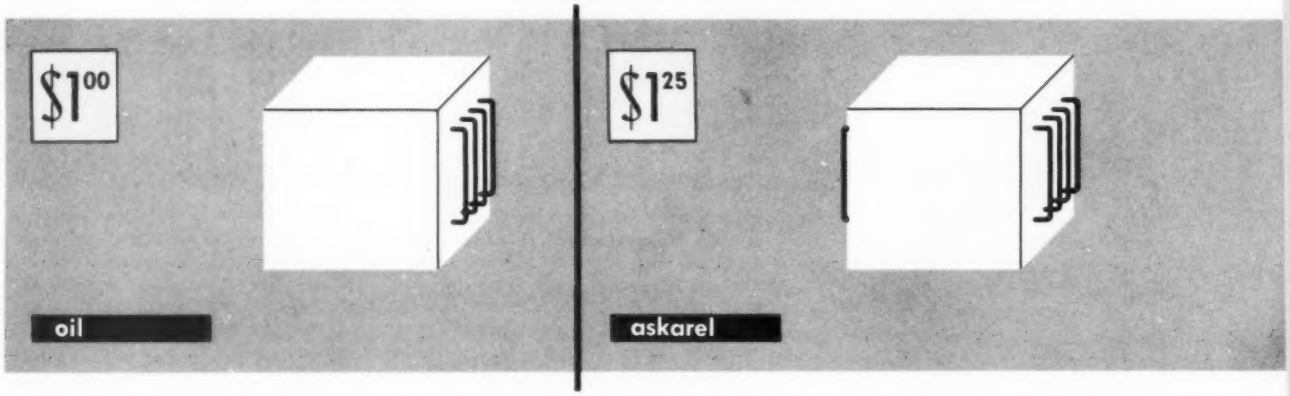
Today's transformers offer top reliability and higher efficiency . . .

Transformers get a heavy play in the industrial plant for primary and secondary substations, changing voltage at individual machines, matching lighting needs (p 123). They're broadly classed as *wet* or *dry*. In wet types the liquid, oil or askarel, serves as a primary heat-transfer medium and insulator. Dry types use air or inert gas in place of liquid. Askarel and dry types are being used increasingly in unit substations.

Transformer Design. Trend is toward greater safety, dependability, sleek appearance, and to higher voltages and ratings for single units. In large transformers, tap-changing under load is now well established (pp 82, 83). Impulse testing as the manufacturer's "proof test" of design has contributed much to growing dependability. Grain-oriented steels in cores have raised flux densities.

Field experience has confirmed manufacturers' belief that the four available oil-preservation methods (POWER, June 1952, p 79) will maintain oil in serviceable condition. Even so, mineral oil is now available with inhibitors aimed to cut oxidation and sludging. Portable oil reclaimers are being used while transformers are energized, to sandwich in maintenance oper-

Oil- and askarel-filled units offer highest impulse levels while . . .



Biggest kva volume of transformers is oil-filled, generally limited to today's outdoor primary substations. Fireproof vault is needed if put indoors. Water-spray or CO_2 extinguishing systems, manual or automatic, are used for important units. Water spray is insulator (POWER, Oct. 1950, pp 110-113) and protects adjoining bays. CO_2 is good for vaults.

Free-breathing units are largely superseded by *conservator* type and *sealed-nitrogen* units to hold absorption of oxygen and moisture to a minimum. Newer designs employ an oil-conditioning unit, built into transformer tank wall.

Askarel, a nonflammable liquid, side-steps oil's fire hazard yet retains high impulse level. Use only in transformers specifically designed for it, indoors or out. If indoors above 15 kv, keep in vaults for high-voltage protection.

Chlorine gas is generated if arcing occurs in tank. So units over 25 kva have (1) pressure-relief vent leading to outdoor flue, or (2) gas absorber installed on transformer case. Engineers lean toward gas absorber to avoid running flue. In some plants, especially well-ventilated ones, local inspector may permit vent alone, minus flue or absorber.

Fan cooling or a larger transformer? Here are the factors to check before deciding

A forced-air cooled transformer with two sets of fans may have three ratings: (1) self cooled (2) with one set of fans (3) with all fans. This is a *triple-rated* unit. High-velocity fans can boost top rating of large liquid-filled transformers to 1.67 times self-cooled rating. Dry-type units usually benefit greatly from fans because cooling air comes in direct contact with windings.

Pros and Cons. Fans are often specified on industrial transformers since they are one of the few means of increasing rating of an existing installation (POWER, June 1952, pp 76, 77). But because fans increase rating by a percentage of the self-cooled rating, benefit is small on small units. Cost of fans and controls is relatively fixed, so many engineers can't see their value for transformers below 500, or even 750, kva. But at 1500-2000 kva and up, fans often prove quite economical.

Consider transformer losses when operating at higher ratings with fans. Other factors are noise and maintenance —often higher for fans and controls than for unit itself. So carefully evaluate whether fans, or next larger transformer, is best long-run bet.

Using Fans. Forced-air cooling may be used to: (1) provide additional capacity for peaks, with normal loads handled by natural circulation (2) lower oil and copper temperatures where ambient is high and unit couldn't carry full rated load without exceeding recommended temperatures (3) carry larger continuous load than the self-cooled rating would allow.

This last scheme often leads to selecting a smaller transformer than is really needed. Power engineers frown on it as shortsighted. Best use of fans is for peaks or to provide for future loads. In latter case, arrange for cooling when you buy the unit, then you can easily add fans later if capacity is needed.

. . . askarel and dry types are moving ahead for indoor installation

ations during regular work hours.

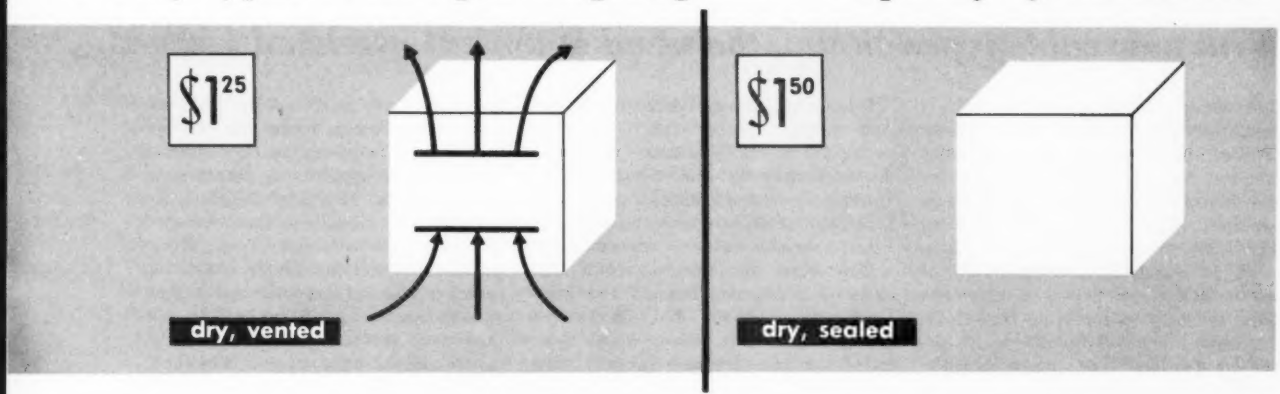
Size. Improved steels have been big factor in reducing physical size for a given rating. Further squeezing may come with improved insulations. But pendulum may swing in the other direction if use of aluminum grows; for given current rating, more aluminum cross-sectional area is required. Some manufacturers are now turning out aluminum-wound units.

Another factor in size reduction that also cuts cost is the single 3-phase unit, now used in place of three single units. Considering top reliability of today's transformers there's little justification for leaning on more costly open-delta plan.

Insulation. As more is learned about the true limits of each insulation, the amount is generally reduced. Greater dependence is placed on arresters to cope with overvoltages rather than insulation bulk. Sealed tanks and modern oil-preservation methods have helped to stretch insulation life.

Tomorrow's insulations will grow out of synthetics rather than organic materials. Typical today is class H (p 114). Vented dry types are now available with class H; this permits operation in humid atmospheres without using space heaters during shutdowns.

. . . dry types boast light weight, greater simplicity of installation



These are getting a big bid in industry today. They eliminate maintenance of liquids, yet present new problems of their own. Dirt accumulates within housing so side plates must be removed occasionally and the unit blown out.

Avoid installation in production areas of textile and chemical plants; lint and fumes are trouble sources. Consider locating in well-ventilated, separate room in such plants. With some insulations you may run into moisture-absorption problem during shutdown in seasonal plants. Power engineers are licking this with built-in electric heaters.

Here is newest addition to transformer family. Although premium priced, it offers absolute sealing with inert gas at slight positive pressure. This keeps air, contaminants and moisture from windings. There is no maintenance other than occasional inspection. And this design is less noisy than vented dry type -- an important angle in some installations.

Being submersible, there's no need for a special location when installing. But if serious flooding is a possibility, give thought to additional anchoring. Future: Power engineers will fast see its advantages and justify added cost.

Power engineers lean toward newer sealed dry type for wet, dirty or hot locations

Looking into the past, we can see the now-retired air-blast transformer used for street-railway work as the forerunner of today's dry type. Modern designs made their formal bow in the early 1930's. Some 12 years ago, sealed units came in, and with them inert gases.

Vented Designs. Vented dry types with class B insulation have been used for years, usually in clean, dry surroundings. But they've fared well even under tough ambients. During World War II many were exposed to moisture, lint, dust and sometimes corrosive fumes. That they stood up under these nonrecommended conditions, even though for relatively short periods, is a tribute to modern transformer design.

Newer sealed designs would have been a better choice. When specifying sealed units, power engineers consider their many advantages: (1) Little maintenance is needed. (2) Transformers can be installed in dirty locations provided periodic checks are made on bushings and gas pressure. (3) Units can be used indoors, outdoors, even where flooding is a possibility. (4) Contaminants can't get at insulation to decrease voltage strength. (5) Minimum oxidation means longer insulation life.

Today's Sealed Units. These fall into one of two groups, based on insulation used: class B or class H. (Both insulations are also available in vented units.) Right now, class H is highest in cost. Some engineers, basing their thinking on field tests, feel a nitrogen-sealed unit with class B insulation will operate in class H temperature zone without material effect on life.

But majority looks to the class-H-insulated unit, preferably sealed in nitrogen, as the one to select for holding tomorrow's maintenance costs in check. It is being installed where extremes in load, temperature and atmospheric conditions must be met successfully.

First decision, properly made in the early planning stage, is whether primary distribution lines will be overhead or underground. Trend is toward overhead. It offers a lower cost system that's easier to expand. But don't make decision on trends alone. An underground system, although it costs more, is unaffected by lightning, plant fires, cranes, etc. And where appearance is a prime factor (if your plant is in or near a residential area) you have another vote for underground. Soil contamination, corrosive fumes, building layouts, distances between buildings, all influence final decision.

Utility tunnels, carrying power services between powerhouse and outlying buildings, are used in some plants. All the power services – steam, water, air, electrical cables – are included. Prefabricated tunnels are available, offer installation savings.

Type of conductors, insulation, covering, come next. Conductor size for load carrying alone can be found from standard tables and voltage-drop charts. But size for short-circuit-current carrying is another matter. With wider use of breakers on feeders and selective tripping with its necessary time delay (p 106), your cables must be able to stand short-circuit heating during the delay period. Sizing for this factor is based on allowable temperature rise of insulation and on time delay period.

Aluminum or copper is another decision to make early. It won't do to design the system for copper, then swing to aluminum later. Size of conductors, pullboxes, etc., must be larger for aluminum.

More power engineers see long-term advantages of standardizing on cable sizes. Even where it means oversizing, resulting simplification pays off both dur-

With new cable types on tap, the trend is toward overhead high- . . .

Current-carrying capacity, line losses, voltage drop, provision for future needs, all face the power engineer planning primary and secondary distribution. Handbooks and manufacturers' catalogs generally give enough information on this score. Assuming this data is at hand, let's look here at the types of cables finding use today, more specifically, several now receiving major consideration.

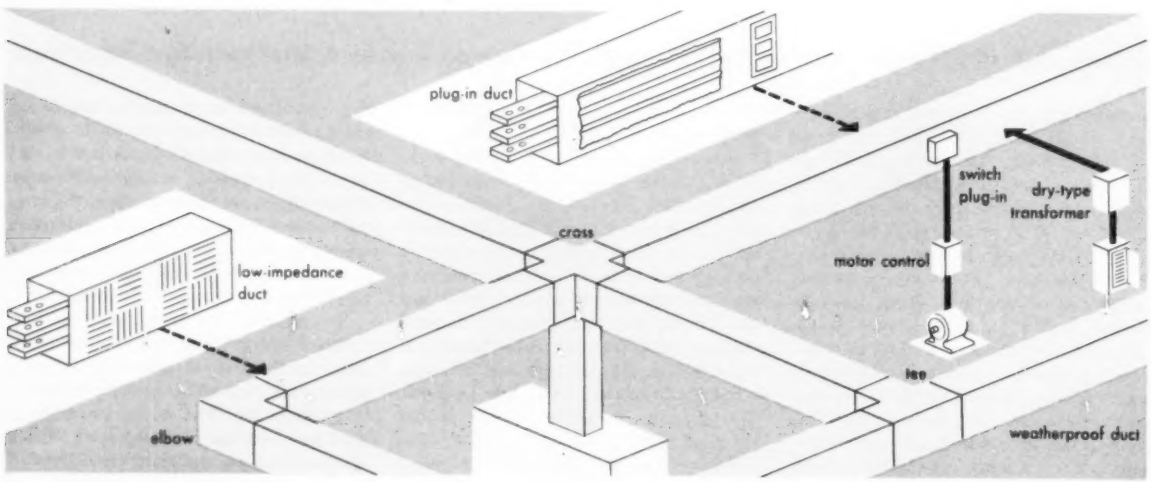
Primary Feeders. Today's plants, made up of many smaller buildings, spread over large areas. Electrically, that spells scattered load units and long primary feeders from either the primary substation or the plant powerhouse. This scattering of load over large areas has been a significant factor in the trend to overhead primaries.

Preassembled aerial cable is a low-cost method getting much attention, especially in modernization programs. An existing pole line, tower line or structural-steel framework for conveyors, pipes, etc. can serve as cable support. For a 3-phase circuit, this cable is made up of three insulated, shielded and jacketed conductors bound to a messenger. Cable needn't be kept clear of towers or buildings, except where chafing is probable. Close spacing with other cables and materials, plus minimum allowable ground clearances, lead to great freedom in choice of supports. Where neutral is grounded, messenger may serve as neutral to carry phase-unbalance currents. Terminating and splicing is simplified, since the cable is made up of separate conductors that are individually insulated and jacketed.

Interlocked-armor cable gets the nod from many power engineers for 3-phase primary distribution above ground level. This grown-up version of long-familiar low-voltage armored cable may be used indoors or out. Outer metal armor, either galvanized steel, bronze or aluminum, covers a chemical and moisture-resistant sheath. Combination forms flexible conduit and conductors in one easy-to-install cable. Bronze armor is a frequent choice in chemical plants. Standard hardware and supporting racks are available. Terminating and splicing methods have been worked out to cut field labor to the bone.

Users of interlocked-armor cable report sharply reduced installation cost once methods are mastered. Where this

Bus-duct has proven itself as the modern key to compact secondary distribution . . .



ing installation and after the plant is in operation.

In many plants the torch is bowing out to bolted and compression fittings for cable joining.

For underground ductwork, fiber conduit in concrete is a good bet. Under light traffic, little concrete is required and top of conduit need not be more than 18 in. below surface (somewhat lower in cold climates). For stretches exposed to heavy traffic, lay conduit deeper, consider reinforcing.

Cable reliability boils down to selecting correct cable, connectors, insulation, covering. Lead-coverings are giving way to newer synthetic insulations. This avoids need for costly lead wiping.

Many are adopting new liquid-tight flexible metallic conduit. Liquid-tight covering over flexible conduit permits use outdoors, in wet spots indoors. Typical use: leads from rigid conduit to motor box.

High points in cable selection

What are on-the-job conditions? Will cable be in conduit, underground ducts, buried in earth, suspended overhead? Consider load, voltage, location, ambient conditions, hot spots, mechanical interference. Is electrolysis a potential problem?

What is best insulation and covering? Get to know the newer insulation materials and conditions for which each is best suited.

What are limitations? Determine maximum current-carrying capacity under the cable's operating conditions. Study effect of your cable selection on installation. Simple example: Two, or more, single cables, in parallel, often prove more economical and easier to install than one large cable.

. . . voltage primary distribution: low installed cost, easy expansion

isn't the case, trouble can be traced to lack of advance planning to take full advantage of this cable's economy. Since conduit isn't needed, there's no confined air space around conductors: this translates into 20% greater current capacity than for same cable in conduit.

Underground Distribution. For this, many engineers are shifting to butyl-base synthetic cable insulation. This serves in conduit, underground ducts, tunnels, also directly in the earth. Cable can stand rough treatment, survive nearly any atmospheric condition, operate in the 80-85 C range with proper jacket.

Varnished-cambric lead cable is an old standby and still first choice of many for underground distribution. Labor costs for handling and terminating are high. Lead sheath offers virtually positive assurance that moisture will not enter cable. Also, sheath's low resistance offers good grounding protection; its thermal capacity helps absorb heat from short-time overloads. In spite of these time-proved advantages, high installed cost of lead-covered cable causes industry to look to newer and less costly cable types.

Secondary Feeders. Selecting cable for hot or damp locations has always been a headache. But a relative newcomer in this country promises to be the best solution in some cases. This self-contained wiring system comprises copper jacketing enclosing conductors spaced and insulated by noncombustible mineral insulation. It is completely moistureproof, can stand continuous operation in ambient temperatures up to 250C. There is no need for conduit; copper sheath usually offers sufficient mechanical protection. Aluminum may be used for sheathing in the future.

This wiring system is rigid yet flexible, so hand-pressure bending is usually enough to shape to any needed contour. Once formed, wiring stays put when fastened with straps. Fittings seal both ends of run at terminal boxes. Because of all-mineral insulation, system is claimed to be immune to age-deterioration. Insulation is stable up to 2800 C. Power engineers are looking into this wiring for jobs where moisture, heat or restricted space are problems.

Interlocked-armor cable also sees use for low-voltage feeders, with same advantages as for high voltages. Unique virtues of bus duct are cited below.

. . . since power loads are plugged-in, changing machine location becomes simple, fast

You'd be out of tune with modern secondary distribution methods if you didn't consider bus duct where shifting of production machines is common. Bus duct is a metal-enclosed system of bus bars (generally copper, but aluminum is coming in) available in prefabricated sections, for simple installation. Prefab fittings – tees, elbows, crosses – make running duct in any direction and around obstructions a field assembly job rather than a major construction problem.

Plug-in feature permits fast connection and disconnection of machines on production floor. Plants can be retooled, buildings revamped, without major wiring changes since bus duct, unlike conduit and cable, can be taken down and reassembled with minimum labor, using same parts again.

Users of bus duct cite three major advantages that tie in nicely with any modernization program: (1) Maximum flexibility meets changing future demands. (2) Simple installation chalks up labor savings. (3) There's minimum disruption of service during changes and it's easy to tie in with other secondary distribution methods.

There are four distinct types of bus duct available today that generally meet all distribution needs. *Plug-in duct*, most used for branch runs, provides outlets for plugging-in switching equipment about every foot. Where machines are to be swapped around, you need only unplug switch and push it into another outlet at new machine location.

Low-impedance duct is logical choice for long feeders where voltage drop must be held down and currents are heavy. Even for short runs where impedance is important, as with welder loads, low-impedance duct is a good bet.

Weatherproof feeder duct, for outdoor runs, has gasketed steel enclosure and weather-resistant hardware. Where voltage drop must be kept to a minimum on outdoor runs, use *weatherproof low-impedance bus duct.*

Aluminum is here for bus duct. Aluminum-oxide problem (see next page) is being challenged with zinc-copper-silver plating. Maker knows this will remove aluminum oxide and predicts it will prevent oxide reforming when duct is in operation. At joints, pressure-compensating spring washers give pressure, claimed permanent, of over 1000 psi. Early figures point to 41% weight advantage over copper.

Advances of a generation ago, such as rubber compounding, look like minor changes when stacked up against developments in insulation and coverings made in the last 10 years.

Synthetic Rubbers. During World War II, natural rubber dropped out, and synthetics substituted. In but a few years, both cable makers and power engineers found many factors favoring the new synthetics. So many, in fact, that natural rubber is now disappearing as a wire and cable insulation.

Heat is the great accepted enemy of insulations. But the "cold" rubber in today's type R does a good job of resisting heat compared to type R of some years back. Going further still is type RH-RW; although a little more costly, it's being used enough to materially affect sales of type R.

Ozone-resistant butyl-base compound is another excellent performer. It's today's dependable compound for voltages to 15 kv, and often higher, offering stability, slow aging, low pf, other desirable physical and electrical characteristics.

Neoprene jacketing for rubber-insulated cables is making big strides. Relatively inexpensive, it's dependable under many tough conditions in moist or dry conduit, in earth, or in aerial runs. Silicone rubber is another newcomer. Its resistance to heat, many oils, solvents and other chemicals makes it suitable for some process-plant applications.

Thermoplastics. You can do a wiring job in your plant today using only materials that barely existed in 1940 – typical are the thermoplastics, polyvinyl chloride and polyethylene.

Polyvinyl chloride – pvc for short – fits a wide range of applications. It resists oils, acids, alkalis, greases, gasoline, moisture, abrasion. With normal treatment and protection it offers long life. We've mentioned but a few of the thermoplastics. The list has grown long in recent years: Rulan, Nylon, Cardolite, Saran, Tenite II, Styraloy, Teflon.

typical modern cable insulations: temperature and voltage limits

insulation, type	recommended max size, awg or mcm		maximum ratings	
	single conductor	multi conductor	copper temp, C	voltage
thermoplastic				
types T, TW	2000		60	600
polyethylene	4/0		80	5000
"thermoplastic" NEC	4/0		60-105	600
thermosetting				
types R, RW	2000	750	60	5000
type RH	2000	750	75	5000
type RU	2		60	600
performance	3000	1000	60	8000
ozone-resistant	2000	750	75	28,000
all-asbestos				
type A	8		200	300
type AA	4/0		200	300
type AI	8		125	300
type AIA	1000		125	600
asbestos-varnished-cambric				
types AVA, AVL	1000	500	100-110	5000
type AVB	1000	500	90	5000
varnished cambric				
shielded	3500	1000	70-85	28,000
nonshielded	3500	1000	70-85	17,000
impregnated paper, solid				
1/c nonshielded	3500		60-85	75,000
3/c shielded	—	1000	63-85	46,000
3/c nonshielded	—	1000	75-85	15,000

Logically, thermoplastics replace rubber for some applications, but not all. Toughness of thermoplastics permits use without protective braid. This factor alone means smaller over-all diameter, less space needed in conduit. In modernization programs where existing conduits are reused, more copper can be pulled in, an important consideration when rewiring commercial and institutional buildings.

After mastering basic differences between aluminum and copper . . .

Aluminum is working its way into plants as an electrical conductor. It is growing in importance as cost of aluminum continues to drop. In time it will find its proper spot; but copper is, and will remain, the No. 1 conductor.

There's nothing really new about all this. Back in 1898, the light metal was installed as a bus conductor in the 600-v 60,000-amp bus at Niagara Works. Aluminum tubular conductors for outdoor switching stations followed. Here it offered resistance to weathering and longer permissible span lengths. It also found application in the chemical industry where copper corrosion was a problem. Aluminum has seen service in plating rooms where sulphuric-acid, cyanide and cadmium-oxide fumes are present.

Where it Fits. Aluminum has natural advantages fitting it for several spots in the industrial system. For overhead installations, light weight per amp is a major factor. The fact that larger diameter is needed than for copper proves of little importance overhead since no conduit is used. Another natural is buswork in primary substations. But to find suitable applications in your plant calls for an engineering study weighing all facts.

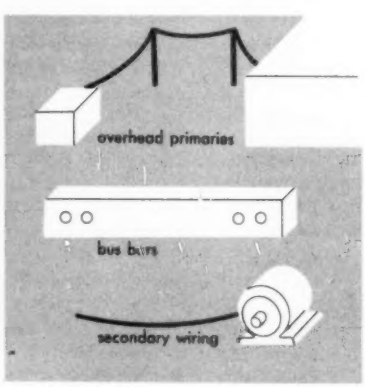
There's less advantage in going to aluminum for smaller conductors. By small we mean about No. 6 or less. In this range, weight advantage is little and greater number of connections may quickly cancel out any other advantages. Connecting aluminum has been a problem. At present most field troubles crop up because electricians and even some design engineers, fail to get more than a nodding acquaintace with the "how-to" side of aluminum as a conductor in wiring systems.

Aluminum is Different. When aluminum building wire bowed in shortly after the last war, its hard-drawn finish gave it an undesirable "springy" quality. But an intermediate temper was adopted that gave better handling qualities. This change in tempering also improved "nickability"—breaking off if accidentally nicked by the knife when insulation is skinned.

But there still are basic differences between aluminum and copper. Size is one. Copper is a better conductor; aluminum is about 61% as conductive for any given wire diameter. This factor alone generally dictates larger conduits for aluminum. And there's where an aluminum installation can go off base.

You can't decide, after conduit runs are laid out, and perhaps installed, that aluminum would be a good bet in some part of the system. Aluminum must be designed as a system: it needs its own connectors, larger boxes and conduit.

Aluminum Oxide. When aluminum is exposed to air, an oxide forms. A poor conductor, it can be scraped off but reforms immediately. Today's procedure coats cable with one of several available compounds; oxide is then removed, usually with a wire brush. Cable end, compound and all, is put into connector. With compression-type connectors, pressure rubs oxide film off cable strands. Since all air is squeezed out of joint, in-



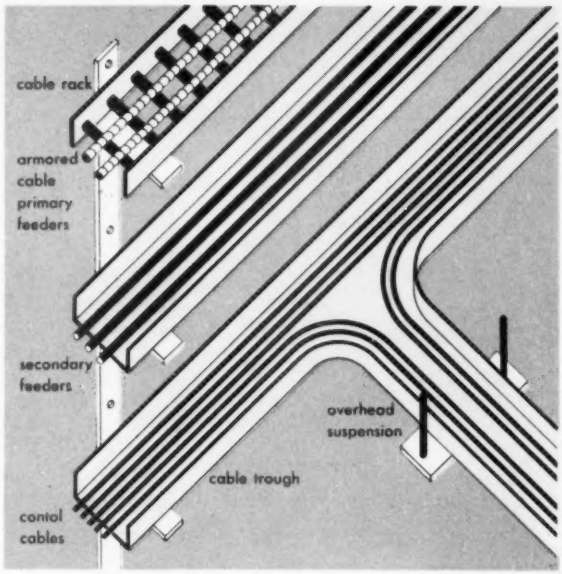
Rigid conduit has been the backbone of industrial wiring systems for generations. In the days of lower labor costs, necessary threading, cutting and bending wasn't as critical. And there was no substitute that offered all the advantages of conduit: top mechanical protection, good electrical conductivity (important for neutral grounding).

Thinwall Conduit. During the 1930's, thinwall conduit began cutting its teeth in industrial plants. It offered light weight, easier cutting and, of greater value, no threading. Compression couplings and terminal fittings, slipped over the new conduit, permitted installation with only hand tools. Bending became an easier job with tools designed to handle the thinner tubing (POWER, May 1953, pp 128, 129).

Trays and Ducts. Thinwall was just the beginning of a concentrated effort to find low-cost easily installed raceways. Trays and ducts have and will continue to be used, especially where many wires or cables are to be carried in the same general area. Typical would be control wiring and low-voltage secondary feeders. Trays are available prefabricated, complete with fittings to dodge around obstructions. Their big feature is ability to carry many wires and cables in the one raceway. And when future additions call for more, it's a simple matter to lay the needed additions in place, if ample space was provided in original design. Today's trays are generally made of expanded metal for lightness.

The self-contained wiring systems (interlocked-armor and mineral-insulated copper-sheathed) fit into this move to develop low-cost enclosed wiring systems.

Where trays and racks are used in place of conduit, general practice today dictates keeping primary, secondary and control cables segregated. A typical arrangement is sketched, *right*. Note the ladder-like rack serving as support for the high-voltage primary feeders of the interlocked-armor type.



Is rigid conduit out as a raceway in industrial plants? Far from it. Where top mechanical protection is needed, there is no substitute for heavy-wall rigid conduit. But where number of cables required calls for running a large number of conduits, and where degree of protection offered by conduit isn't needed, trays and ducts are a likely answer.

. . . *engineers find more uses for light, corrosion-resistant metal*

sulating oxide film doesn't get a chance to reform. Result: A good electrical connection between strands in cable and between cable surface and connector.

Electrolytic Action. This is another factor to consider when joining aluminum and copper where moisture is present. A miniature electric cell can be set up and one of the metals, aluminum, will be eaten away. Solution appears to be use of tin-plated aluminum lugs. Place aluminum above copper so copper salts formed will flow away from joint.

Aluminum has a higher creep rate than copper. That's why connectors for aluminum have more surface — to reduce pressure on conductors in joint yet keep them from working loose.

Thermal expansion differences between copper and aluminum must also be taken into account. Aluminum's coefficient of expansion is about 38% greater than copper's. Thus, usual run of copper connectors are not suitable. For a good joint, connector must be designed to handle the differences in rate of expansion of the two metals.

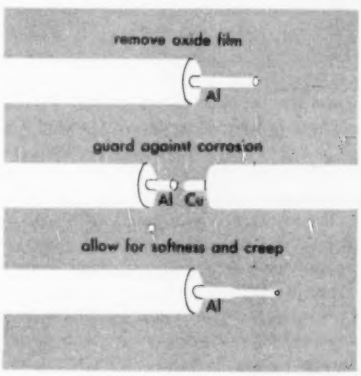
Making Joints. In addition to the facts outlined above, remember that joints can also be made with standard heat methods. Aluminum solder, used with suitable flux and torch, will turn out a satisfactory aluminum-to-aluminum joint. On a large job, calling for many joints, consider use of argon-arc welding and aluminum terminals. No flux is needed. Resultant weld is clean, completely conductive, free of inclusions.

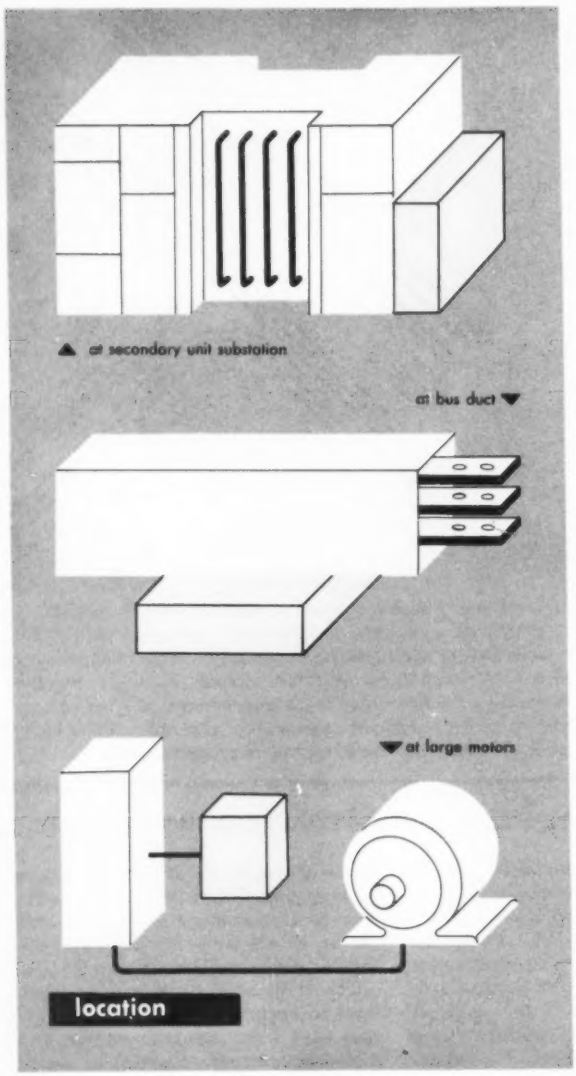
Bolted or compression fittings often give a faster and more reliable joint. Bolted fittings cut down installation time and require few tools. If made of copper or copper alloy, they are coated to protect against electrolysis.

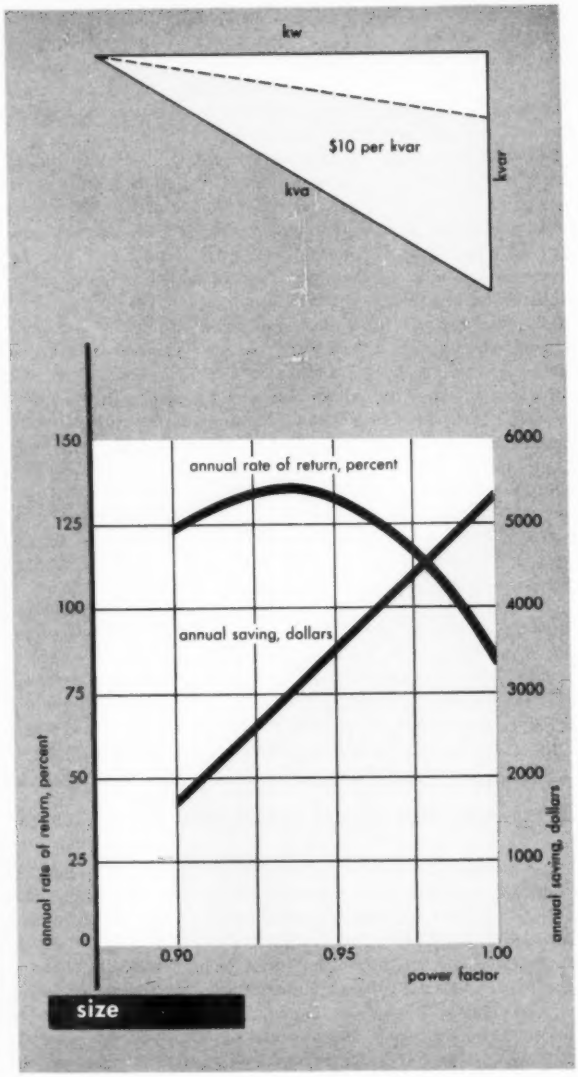
Compression Fittings. These have been used for over 40 years, primarily on overhead aluminum transmission lines. Now similar fittings are available for use on insulated wire and cable. Special tools that exert heavy pressure are used for application. Pressure compresses body of fitting around the cable, forming a deep indent. Cross-sections of compression joints show that cable strands in the fitting have been packed into practically a solid mass. Wiping action of metal during compression breaks the oxide film, yielding low electrical resistance. Whether bolted or compression fittings are employed, however, good practice calls for a suitable compound to maintain a good joint.

All things considered, aluminum as a conductor in the industrial plant is here and will remain. Manufacturers anxious to exploit aluminum's advantages have largely overcome the space and connector problems in their equipment. Plant electricians like aluminum because of its lighter weight. But you'll have to keep close tabs on them until they become familiar with using it, and they'll have to pay attention to details of good practice.

When you buy equipment, tell the manufacturer whether you plan to use aluminum with it. Otherwise it may be delivered to you with copper connectors, probably unsuited for aluminum.







Today's power engineers are well aware of the advantages of high power factor (POWER, July 1953, pp 84, 85). They weigh carefully the pros and cons of using synchronous motors instead of capacitors, to raise pf and get an efficient motor to boot. So, skipping theory and benefits of pf improvement, let's tackle question of locating and sizing capacitors.

Three locations used widely are: (1) at secondary unit substations (2) on secondary bus duct (3) right at motor load. Trick is to put them where they do most per dollar invested.

Locating right at motors generally means greatest investment but usually does best job. You can eliminate switching, since capacitors are connected and disconnected with motors. This proves an excellent location provided motors are large and operate quite steadily. When motors aren't operating, the capacitors represent a substantial idle investment.

If your main aim is to cut utility charges by improving pf, a central location near incoming lines is the best bet. This generally costs less, but you lose some plus values—increased plant feeder capacity, reduced power losses.

Where induction motor loads are small, or where large motors operate intermittently, secondary unit substations are becoming a common spot for locating a capacitor bank.

The practical way to determine capacitor size is by calculating rate of return and actual dollar savings for various final pf's in your plant. Sketch above shows typical form.

What's limit? When incremental saving for each capacitor kvar added fails to be economically attractive. It's rate of return on capacitor investment that's important, but final pf isn't limited to point corresponding to maximum rate of return. It may be worthwhile to go beyond this point, even though rate of return is less, if additional system capacity is released. Rate of return is often greater for small plants because their loads won't justify the best utility rates.

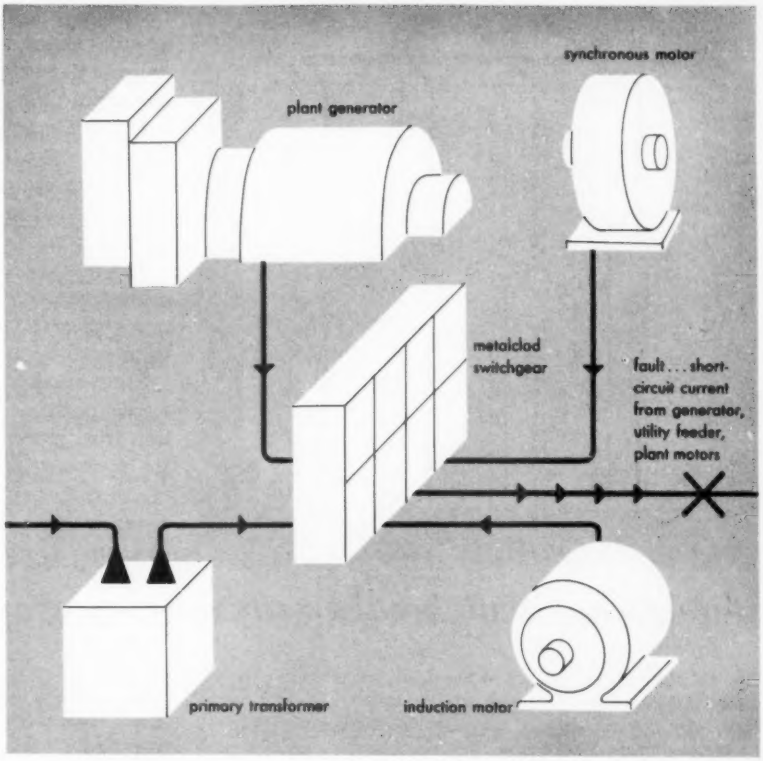
Developing harmonics as a result of a sizeable capacitor installation is still a matter of concern, generally unjustified, to some engineers. Theoretical calculations reveal possibilities of harmonics and resonance, but if plant voltage is approximately normal, it's practically impossible to overload a capacitor by harmonics. Remember, capacitors don't generate harmonics: sources are transformer magnetizing current, rectifiers, arc furnaces, generators.

Manual switching of capacitors is adequate in most plants. Where kvar of capacitors is greater than two-thirds of the transformer rating, figure on automatic switching.

Larger utilities, heavier interconnections, larger plant generators, bigger motors – all mean that when a short occurs vastly greater currents flow into it. In existing plants as well as new ones, circuit protective devices thus need much more *interrupting capacity*. Lack of it could easily cause a plant shutdown. Two steps will keep you out of such trouble: (1) Know available short-circuit currents in your plant. (2) Be sure breakers will handle them.

Start by getting the incoming figure from your utility. From there on, steps in determining available short-circuit currents at any point on your distribution system have been boiled down to simple arithmetic. Check with your equipment manufacturer – several have developed simplified methods of short-circuit calculation.

In selecting interruption equipment, be sure to allow for tomorrow's needs as well as today's.

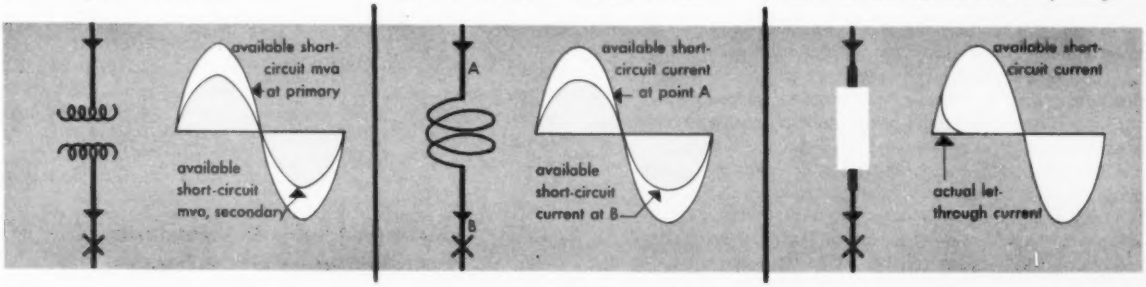


Adequate circuit-breaker interrupting capacity takes first place

transformers Include transformer impedance in short-circuit calculations but don't specify higher than standard as it may lead to voltage regulation trouble. Consider using several smaller transformers in primary sub and splitting secondary bus as one means of holding down fault currents.

reactors Designed to limit short-circuit currents, reactors have been used for years in generator leads and bus ties. Now some makers of motor starters supply built-in reactors to hold available short-circuit currents to values that can be safely handled by motor contactors or circuit breakers.

fuses Properly applied, high-interrupting-capacity fuses chop short-circuit current off in first quarter cycle, before maximum is reached. Transformers and reactors modulate current values; fuses, like circuit breakers, interrupt it. But circuit breakers often allow several cycles before opening.

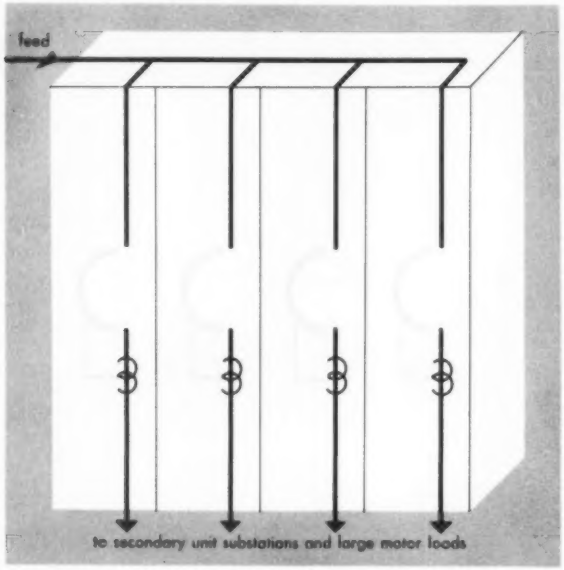


But consider other circuit components that limit value of short-circuit currents

Before jumping to reactors to cut available short-circuit currents, consider how they'll affect over-all plant operation. For instance, on main feeder bus, they must be sized to limit current values in all branches off it, may seriously affect voltage regulation. And a fault on any branch circuit pulls voltage down equally on all other branches, may cause the under-voltage releases to kick out.

Power engineers now like to put reactors in branch circuits, protecting a group of small breakers. Each is independent and reactor is unaffected by added loads on main bus. Four impedance values meet most low-voltage needs in secondary circuits: 0.010, 0.015, 0.020, 0.025 ohms. Each is available to cover a range of fault currents. Since control centers provide for a 600-amp bus, maximum-continuous-current rating of reactors for them need not be more.

Look at voltage regulation again before applying reactors: How much will voltage change from light to full load? How far will it dip during motor starting? Would larger breakers be better?



Mainstay in most protection plans, today s circuit breaker keeps pace with growing demands for more reliable protection, minimum downtime on faults.

Industrial-plant breakers, on secondary of primary substation transformer and in secondary substations, use air rather than oil in contact-breaking chamber. In modern switchgear, individual breakers (also meters and instruments) are removable so maintenance can be done with equipment deenergized.

The few cycles needed for breakers to trip allows protective relay to close contacts, breaker trip coil to move plunger releasing breaker operating mechanism, and opening contacts to interrupt current.

Short-circuit current is maximum during first few cycles because of dc component and peak contribution from motors on line. Thus, there are two bases for short-circuit-current ratings of circuit breakers: (1) *momentary rating* — ability to stand mechanical stresses which are maximum during early cycles (2) *interrupting rating* — ability to break circuit safely.

Here's how circuit breakers are now being applied in primary and . . .

On the preceding page we stressed the importance of adequate interrupting capacity in today's protective equipment. Now let's look at some of the practices being followed by power engineers in applying this equipment.

Primary Substation. If a main transformer breaker (in unit's secondary leads) is used in the simple-radial system, overcurrent relaying can be applied to trip this breaker as backup protection for plant primary-feeder breakers. Main job of this breaker, from system-protection standpoint, is to detect and isolate faults on primary substation bus. Relaying for breakers, however, must be coordinated with other protective devices in system. Thermal overload protection for primary-substation transformer can also control this breaker.

With modern unit-substation construction, however, it is now general practice to eliminate the transformer breaker. This can be justified by the compactness and extreme reliability of unit-type equipment, which makes possibility of a primary-substation-bus fault remote. In large primary substations, possible use of bus and transformer differential protection should be considered. Additional insurance provided must justify premium paid. In some special cases, differential schemes combining transformer and bus protection can be devised with a saving in cost of protective features.

If the utility sub-transmission system supplying plant primary substation consists of a single radial line, no protection is ordinarily provided at substation high-voltage terminals, with possible exception of a high-voltage fuse in combination with a switch. In cases where other independent loads are supplied over the same single radial line, however, the utility may call for an automatic switching device, a circuit breaker, at primary-substation high-voltage terminals. This protects incoming line against outage caused by faults in the industrial-plant system. Such a breaker is generally relayed by overcurrent units, coordinated so that it doesn't trip for faults that should be cleared by primary-feeder breakers or other protective devices in the industrial-plant system.

The high-voltage breaker can provide backup protection for faults on the plant system, and where transformer or bus differential protection is used, the breaker can be controlled by the differential relays.

When a high-voltage breaker is used in the primary substation, there is little justification for using a breaker in transformer secondary leads. Protection normally supplied by secondary breaker can be provided by high-voltage breaker, making one less step in relay coordination.

Secondary Substations. In simple-radial systems, secondary subs are protected in one of two ways. A main breaker can be used between stepdown transformer and secondary bus. If so, breaker permits not more than 2.5 times normal rate of current to the substation transformer. More usually, trip setting of this main breaker is closer to rated current of transformer, common trip setting being 1.25 times rated current.

In the second case, the main breaker is omitted, but sum of trip settings of low-voltage feeder breakers is less than 2.5 times rated transformer current Transformer thermal overcurrent protection can be supplied by some manufacturers.

NEC sets limits within which individual overcurrent protection on primary side of secondary-substation transformers can be omitted (1953 edition, Section 4512). Basically, the Code permits leaving out individual primary overcurrent protection when there is adequate secondary overload protection for the transformer. Also, when primary-feeder relaying can be said to detect faults in low-voltage side of the transformer. If you interpret the Code literally, it permits connecting only 5 iden-

short-circuit currents theoretically possible at various voltages

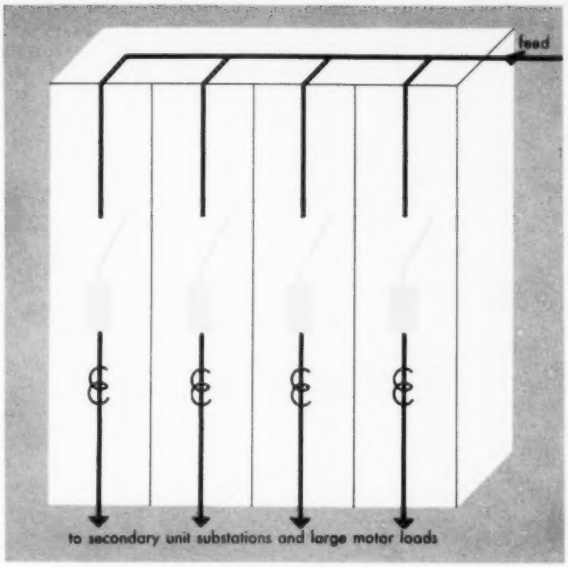
short-circuit energy	short-circuit amp per phase			
3–phase kva	15,000 v	2500 v	480 v	208 v
25,000	1000	5,800	31,000	70,000
50,000	2000	11,500	63,000	140,000
100,000	4000	23,000	125,000	280,000

Note: The above are calculated values discounting impedance that may be met in the typical plant system on secondaries of unit substations

Filling gap between simple air-break switches and circuit breakers, modern load-interrupter switches find use where main need is switching. Where fast resetting of breakers isn't required, where possible single-phasing can be tolerated, combination interrupter switch and fuse serves as economical alternative for more complete service given by breakers.

In industrial primary substations, typical units are able to interrupt 600 amp of load plus magnetizing current. Sizing to interrupt station load means switching can be done without mechanical and electrical interlocking with secondary breakers. Some engineers specify combination interrupter switches and power fuses to give short-circuit protection for primary feeders and secondary transformers. Fuses are usually high-voltage boric-acid type.

Switching centers in large industrial plants, where power is distributed over a series of high-voltage feeders to unit subs, use interrupter switches as an economical means of switching under load.



. . . secondary unit substations, and on incoming utility-power feeders

tical transformers to the same primary feeder without use of individual overcurrent protection on the primary side of the transformers, *when transformer impedance is 6% or less.* If transformer impedance is between 6% and 10%, it is permissible to connect only three transformers of like size to the same primary feeder.

While the code requirement is generally accepted by power engineers today as being approximately correct at 6% and 10% transformer impedance, the regulation is unnecessarily restrictive for other values of impedance. In many cases today, the oversimplification of the Code rule imposes an economic penalty on the industrial-plant distribution system.

Breaker Coordination. Protection at load points must coordinate with breakers at supply end or low-voltage side of secondary substation. This coordination between protective elements depends mainly on the low-voltage-feeder breakers carrying current to supply several branch feeders. Even though ampere-time characteristics of two devices have dissimilar shapes, coordination is generally obtainable because of differences in normal current ratings.

When breakers operate up near point of maximum interrupting duty, opening times of both low-voltage-feeder and branch-circuit protection may be so nearly instantaneous that coordination is impossible. It is for this reason that various schemes have been worked up to provide selective tripping of such devices. For example: A definite time delay is often introduced into the opening of a low-voltage breaker at a high fault-current level to give branch-circuit device enough time to open if fault is in branch.

It was specifically this problem that resulted in recent development of more accurate adjustable series-trip elements for low-voltage air breakers. Since their entry into breaker field, it is usually easier to coordinate characteristics.

Tripping characteristics of a breaker necessarily form a band rather than a line. It's defined by a lower ampere-time value below which the breaker will reset and not trip, and an upper value representing maximum time required for breaker to open circuit for a given flow of current. Usually, if a ratio of 2:1 exists between tripping-current value of larger breaker and smaller, the smaller trips before larger breaker is unlatched.

Network Protection. In a secondary network system, main substation breaker is the network protector. This automatically opens only on reverse power flow. To get backup protection for network protector in case it fails to open, fuses are usually incorporated as part of the network protector. Three fuses generally provide overcurrent protection against currents greater than 2.5 times transformer rated current.

Network relay that trips protector is an induction-type 3-phase directional power relay. An overvoltage reclosing feature is generally incorporated in modern network relays to initiate automatic reclosing of protector when proper voltage supply is restored to secondary substation.

Secondary-Selective Systems. Coordination of tripping characteristics of low-voltage feeder breakers and those in transformer leads is exactly the same as problem met in simple radials. Exception may come when all load is carried by one transformer, as would be the case with a single-ended secondary unit substation.

When substation is operated with one transformer, an added breaker is often placed between main primary breaker and low-voltage feeder breakers. Then if bus-tie trips automatically on overcurrent you avoid difficulty of getting selective operation of main, bus-tie, and low-voltage-feeder breakers.

This is modern metalclad switchgear:

An assembly of main units and auxiliary compartments with: (1) all parts enclosed in grounded metal (2) grounded metal barriers to isolate secondary controls and wiring from high-voltage primary devices, and primary units from each other (3) removable-type circuit breaker having self-coupling primary and secondary disconnecting contacts and a mechanism for moving it physically between connected and disconnected positions (4) interlocks for safe operation, proper sequence.

For top protection, each breaker should have enough interrupting capacity to handle available short-circuit currents at its point in the circuit. Also, breakers in series should have time discrimination so any fault at far end of string will be isolated by nearest breaker and service maintained to remaining loads. When you specify both adequate interrupting capacity and time discrimination, you have the recommended *selective tripping* scheme.

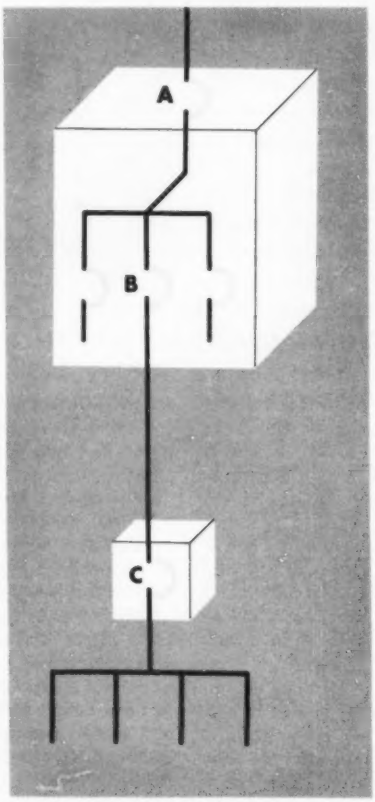
But many engineers find it hard to justify cost of selective tripping on some low-voltage circuits. So they specify breakers in *cascade*. Then only breaker closest to source has adequate interrupting capacity; those down the series string are applied beyond their ratings. If a heavy short occurs, even beyond last breaker, main breaker may trip out, killing all service. Where properly applied (below), cascading is practical but not generally recommended.

selective In sketch, *right*, *C* would be, perhaps, a motor feeder breaker with tripping elements having both long time-delay (for motor-starting duty and overload protection) and instantaneous characteristics (for short circuits). Breakers *B* and *A* would have tripping elements with both long and short time-delay characteristics, time delay for *A* being longer than *B*.

Time-delay feature provides needed time for short-circuit current to trip breaker farther down the line first. Thus, breaker *A* would trip only for a fault between *A* and *B*. Breaker *B* would operate only for a fault between *B* and *C*.

For a selective tripping system, each breaker must have an interrupting rating equal to or, better still, greater than available short-circuit current at point of application. Also, all breakers, except those with instantaneous tripping elements, such as those farthest from power source, have a short-time (30 cycle) rating equal to or greater than available fault current. Then, so current-time characteristics will not overlap for adjacent breakers, current ratings must be selected with a ratio of at least 2:1 to prevent false tripping.

Selective tripping has become a must for essential circuits – such as those supplying power-station auxiliaries.



cascade Breakers are connected in cascade simply as a way of cutting first cost. It's possible for two or all three breakers in cascade to open if fault current is severe. Since smaller breakers are backed by those with higher interrupting rating, their life depends on backup breakers coming to the rescue. But where two or more beakers operate at same time, in series, individual stresses are less than if each opened alone. This is considered in cascading breakers. Makers recommend electrical operation for cascaded breakers.

Where cascading is adopted, power engineers have each breaker in setup inspected after tripping on a heavy fault, before reclosing. Heavy fault current may have damaged breaker so even normal current couldn't be carried safely.

Cascading is usually limited to three steps of interrupting rating. Breaker nearest power source, *A*, must have adequate capacity. Breaker next lower in cascade, *B*, may have ½ interrupting rating required by maximum available fault current, one farthest from source, *C*, may have ⅓ maximum rating.

Before adopting cascading, weigh carefully the disadvantages of reduced selectivity, restricted interrupting-duty cycle, and some additional maintenance.

Weigh cascading's many disadvantages; don't let price tag alone rule your decision

Cascading is far from ideal in breaker application. But seeing that it's with us, and widely used today in industry, make sure you know all the facts, before you choose.

In a cascade hookup, total kva of connected synchronous motors should not exceed 25% of supply transformer or generator kva. Main breaker *A* should be set to trip when current through breaker *B* reaches 80% of its interrupting rating. This insures that main breaker will operate whenever short-circuit duty exceeds interrupting rating of breaker *B*.

Another general practice of power engineers using the cascade scheme is to select breakers from the same maker, to be sure they have similar characteristics.

Molded-Case Breakers. Is it wise to cascade them? Tests have been made by various manufacturers to answer just that question. Tests were independent but results were in substantial agreement. Conclusion: Molded-case breakers shouldn't be used in cascade arrangement. Here's why:

Various types and sizes of molded-case units were tested and nearly all those cascaded were damaged—covers broken, contacts and operating mechanism destroyed, etc. So there's general agreement that molded-case breakers should be used within their interrupting capacity limits, not cascaded.

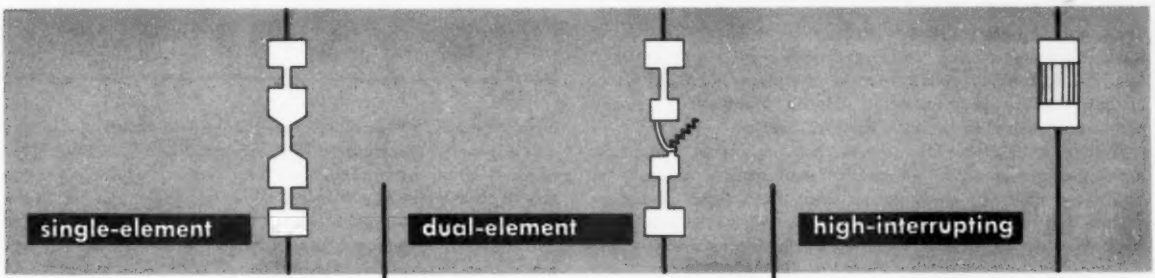
Cascading Disadvantages. Forgetting initial cost for a moment, look into major limitations of cascaded arrangement. Realize that, although you had reliability and service continuity uppermost in mind when you selected a circuit arrangement (pp 88-91), these values can be cancelled quickly with cascading. Unlike the selective-tripping scheme, whenever a feeder fault draws current greater than 80% of interrupting rating of feeder breaker, main breaker will trip. Then service to all feeders served by main breaker is lost and will stay lost until main breaker is reclosed.

In brief, cascading is being used and proving satisfactory in many industries. Your job is to weigh its disadvantages against its lower initial cost and determine which of the two tripping arrangements fits your over-all needs best.

A generation or so back, the fuse vs circuit breaker question was often discussed. But the breaker has since been developed to a point where few engineers will question its place in circuit protection.

In recent years, however, the fuse has moved into the major league in the low-voltage field. Back of this move is the high-interrupting-capacity fuse. It uses a silver element surrounded by silica, has interrupting capacities in line with the needs of modern plants. Its chief boast is that it will interrupt a short circuit before current reaches the dangerous values possible. Some fuse manufacturers look on it as an "anticipator".

On this page and next, you'll find information to help you seek proper spots in your plant for this fuse type. Since there is far from firm agreement on where it fits best, final decision, as always, rests on your good engineering judgment.

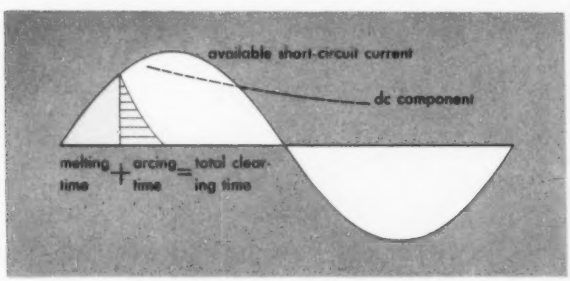


Simplest of fuses has but a single element. On a heavy overload or short circuit, weak spots in the link are suddenly heated to a high temperature and vaporize. Because length of these weak spots is relatively short, any arc formed would continue. But arcs are in series and voltage across each is low, so arc is stopped and circuit opened. Only one weak spot may open on minor overload.

Here fuse link copes with heavy overloads and short circuits, while a thermal cutout takes care of sustained overloads. Current flow generates heat in link. With minor overloads, where there is ample time for thermal conduction, heat is carried into thermal cutout in fuse center. Fusible alloy melts at proper point, permitting interrupter to move under spring tension and open circuit.

High-interrupting-capacity fuse is a tube with silver elements in silica filler. Silver is used because: (1) Conductivity is not impaired by continuous operation or current surges yielding temperatures just under melting point. (2) Having low specific heat, silver can be raised to vaporization faster. (3) Its vaporization temperature is much below temperature at which the vapor readily ionizes.

High-interrupting-capacity fuses offer sound low-cost protection

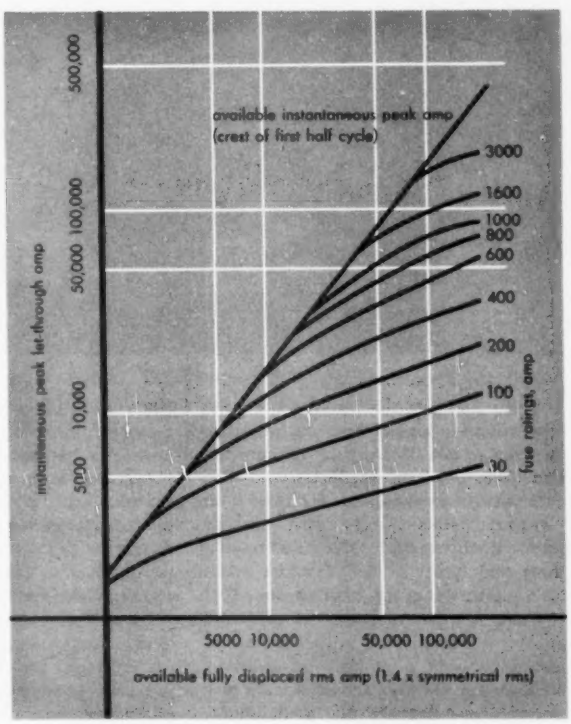


A high-interrupting-capacity current-limiting fuse is designed to open a short within the first quarter cycle, before serious damage can be done. This fast microsecond action in face of high available short-circuit currents (up to infinity) finds new spots in industry for this fuse type.

Magnetic stresses circuit equipment must stand are a function of actual "let-through" current squared. *Thermal stress*, or equipment heating, depends on let-through current squared multiplied by clearing time. Tie these thoughts to the sketch above and you'll see how current-limiting action of this fuse holds in check the dangerous effects of a heavy short.

A symmetrical short-circuit is sketched above. But if the short hit at time zero, dc component would give an asymmetrical wave about a displaced higher-value axis.

Curve to right is plotted for available fully displaced rms amperes (asymmetrical or total rms amp). This is on the basis that maximum offset rms amp equal symmetrical amp multiplied by 1.4. Curves are peak let-through values.



The shortcomings of the Underwriters dc fuse test have been known for years. If a fuse safely interrupts 10,000 amp dc it is approved. In this test, criterion of success or failure is the actual physical condition of the fuse after the test and whether it would create a fire hazard.

But how would an NEC fuse act in ac circuits capable of delivering 50,000, 100,000 or 150,000 amp? To get an answer, one of the leading fuse manufacturers ran tests on 250- and 600-v dual-element fuses. Test circuits were capable of delivering peak currents up to 235,000 amp at rated fuse voltage. Table, *right*, shows results. Fuses cleared the shorts without igniting readily flammable material placed around the fuses. There was comparatively little noise.

High Capacity. Above test is mentioned as a long-awaited step in the direction of determining the proper place for fuses in our modern high-capacity circuits. Meanwhile, today's power engineers look beyond the NEC fuse.

They're watching with interest application of the newer high-interrupting-capacity fuses. In the opinion of many power engineers queried, such fuses lose their major benefit — current-limiting action within the first quarter cycle — if larger sizes are used. Some hold their top figure mighty low — in the 200-amp range. Against this should be set the opinion of many leading consulting engineers who feel the high-rupturing fuse, even at higher ratings, offers sound circuit protection at low cost.

Applications. There are basic applications that aren't questioned. Example: where molded-case breakers are inadequate and larger breakers are too bulky and expensive. And with the passing of time, the high-interrupting fuse will find its proper niche. Of many reported installations (see three below), only the seasoning of experience can determine the most suitable. In the meantime, the fuse is doing a job, and doing it well when applied with appreciation of the limitations of fuses. From the interest shown by power engineers we can safely predict the fuse will find wider application in the future.

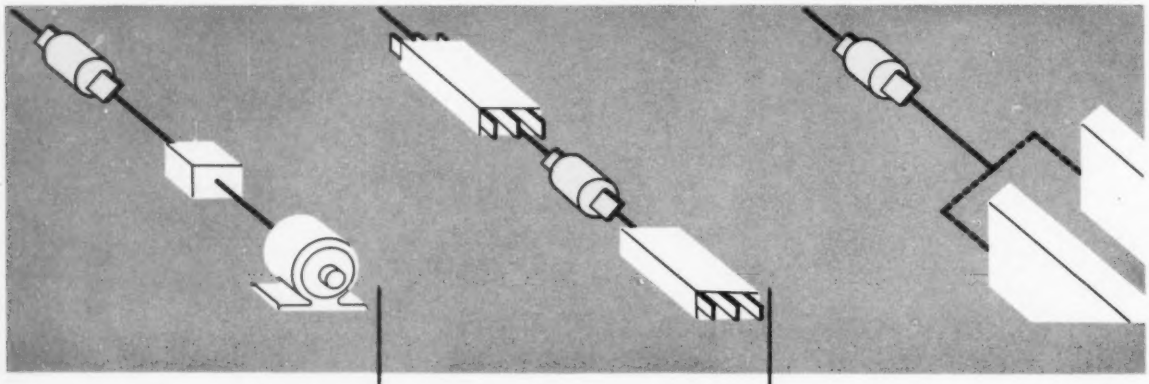
In any installation of high-interrupting fuses, check that plant electricians don't slip standard NEC's in their place when one blows. This is a strong temptation, since many of the fuses are interchangeable. It would be a sound move for the industry to adopt early standards for high-rupturing-fuse holders that would prevent such substitution.

This fuse may have more far-reaching effects than simply acting as a circuit protector. Since it acts to prevent passage of large amounts of short-circuit current, the physical size of the fuse itself, the holder, entrance service switches, motor-starter switches, may be materially reduced. Right now the fuse people are working in this direction.

tests show dual-element fuses have high interrupting capacity, too

fuse rating, amp	peak amp	clearing time, sec	peak voltage
30	8,600	0.0005	410
60	10,900	0.0011	390
100	28,000	0.0018	650
200	50,000	0.0020	840
400	87,000	0.0040	1260
600	126,000	0.0052	1280

Here are a few typical recent applications of new high-interrupting-capacity fuses



Backing up small circuit breakers, where load is tapped from a high-capacity bus, is one of many uses. There are two other alternatives that would also give satisfactory results: (1) Install an adequate breaker — but this may be impractical because of space restrictions and cost. (2) Use reactors available as part of motor-starting unit.

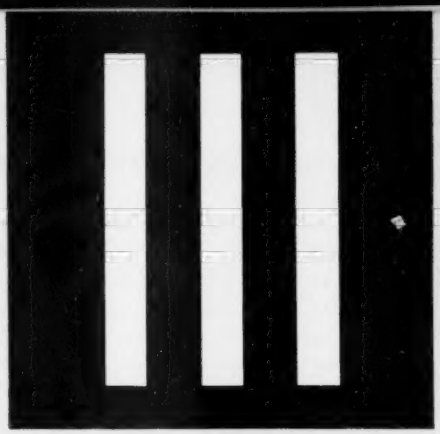
When high-interrupting fuse is used this way, select it on basis of disaster insurance — to blow only on a heavy short circuit. Breaker should handle any reasonable overloads and switching.

High-interrupting fuses have been used between sections of bus duct connecting several substations in parallel on low-voltage side. In one case, four substations, each rated 750 kva, were paralleled through low-impedance bus duct. Feeder taps to distribution panels in production area were uniformly spaced along the bus.

Paralleling bus duct helps equalize load among subs. But since high-interrupting fuses are cut into bus duct line, possible short-circuit current through secondary switchgear is reduced.

Protection of existing switchgear and control centers is another way these fuses are applied. Example: where an added feeder from the utility raised possible short-circuit currents to a value beyond interrupting rating of installed breakers and control centers. This fuse use can be a sound low-cost solution provided fuses selected are really current-limiting in sizes used.

Other engineers interviewed feel such an answer is only temporary. It still leaves switchgear, often old, that lacks safety and reliability of modern gear.



putting electricity to work

1 **Motors.** Better insulations and steels give more motor per pound. Choice of enclosure type becomes more important. Magnetic amplifier off to fast start as need for regulated systems grows.

2 **Centralized Control.** For many plants, modern packaged control centers of several types offer economy, flexibility. But in others best bet is local control with bus duct feeding the loads.

3,4 **Dc Sources • Lighting.** With growing use of dc, the spotlight swings to conversion devices, particularly new designs. Improved fixtures and light sources yield greater over-all economy.

With new insulations, steels, designers obtain more motor per lb

With 85% of industry's machines powered by motors, changes in practice have wide significance. One is a swing to full-voltage starting, even for motors up to 3000 hp. This means simple, less-costly control, less maintenance. But before adopting it, check your generating equipment or utility supply to be sure it can handle the starting currents.

Another trend: Growing use of adjustable-speed equipment and dc motors meets the precision and production-volume demands of modern machines.

Perhaps most important: Motor manufacturers pack more horsepower into each pound of motor. This has been going on for years. But, as of Jan. 1, 1954, you'll see the first trickle of new NEMA rerated motors coming into industry. Some will fit twice as much horsepower into the same sizes.

Today's frames pack more hp

For the time being, this NEMA rerating of motors is confined to integral sizes to 30 hp. How did it come about? Remember, many motor frame sizes used today were established 25 years ago. During that time there have been two significant advances: better insulations and better lamination materials.

Motor insulations, based on 1929 standards, included cotton-covered wire, paper and cotton slot and phase coverings. Impregnating varnishes were made of natural resins, oils and solvents. So to get suitable dielectric strength, a considerable mass of insulation was needed.

Insulations today incorporate synthetic materials. For example, today's synthetic-resin coating on wire is thinner but offers higher resistance to leakage than the old double-cotton covering. Synthetic materials in slots, between the phases and in lead protection, are doing an all-around better job. Synthetic varnishes more thoroughly impregnate, bind and protect the windings.

Thus synthetics mean less insulation mass is required. Less mass of insulation means more copper can be put into a stator slot. Right off, this gives a stronger magnetic circuit. But a big secondary advantage is in heat transfer. Less mass of insulation means greater heat transfer from copper through to the iron and off to the cooling medium.

Better lamination materials give reduced iron loss. These rerated motors will operate at higher flux densities, meaning less iron required for a given horsepower.

But while frame sizes come down, shafting sizes hold the same. Why? There have been no comparable advances in shafting design and materials, so more output from a given frame size means a proportionately larger shaft.

This NEMA rerating is a recommendation *only*, so all manufacturers don't have to adopt it. But they will. To you, rerating will mean need to stock additional renewal parts and some additional motors during the transition period. Will you get the same degree of liberality in design? Yes. More horsepower is being packed into smaller frames, but each motor will hold to all existing NEMA performance standards covering torque, starting current, temperature rise, etc.

For most jobs, ac motors suit

To get the proper perspective on today's motor picture, remember that the ac polyphase induction motor is used in 9 out of 10 industrial applications. This group includes the ever-popular squirrel-cage, the wound-rotor, and the adjustable-speed commutator motor. The squirrel cage is the granddaddy and the widest used. In one form or another, it drives more machines in industry than any other motor type. It is simplest in construction, has fewest wearing parts. This boils down to low maintenance and low first cost.

The usual squirrel-cage motor runs at constant speed. The "multi-speed" type has additional windings, permitting it to operate at two or more fixed speeds. Whatever the speed, it is held reasonably steady regardless of load changes. And because most industrial machines do run at a constant speed, the one or more fixed rates available from a squirrel cage make it suitable for many applications.

The second polyphase induction machine is the wound-rotor, often called the slip-ring type. Speed can be adjusted but will vary with load when far below rated speed. The wound-rotor type fits on a conveyor drive, for example; torque can be increased or decreased to meet changes in the load. Keep it in mind also on power systems with limited capacity; it provides high starting ability with low inrush current.

Third in the polyphase induction group is the adjustable-speed commutator motor. Although little used compared to its brothers in the induction group, this motor offers a speed variation of about 4:1 for continous operation and over 20:1 for intermittent operation. This type often takes the place of a squirrel-cage motor combined with an adjustable-speed mechanical transmission.

When it comes to synchronous motors, we find most of them driving heavy machines. They can start and accelerate even the heaviest loads, pull them at constant speed. About 500 rpm is dividing line between so called low and high speed.

Many plants today are specifiying synchronous motors with 0.8 leading power factor for all big drives. In addition to constant speed and power factor improvement, synchronous motors are also used because: (1) they often cost less than other motors when properly applied (2) they offer a power-cost saving. This results from high efficiency — up in the 93 to 97% range. But when examining the high-efficiency angle keep in mind the somewhat greater maintenance resulting from dc excitation, brushes, slip rings and rotating field.

For speed control, dc gets nod

Where an ac motor won't do the job satisfactorily, consider a dc motor. They are premium priced products, especially in larger sizes. But they offer topnotch adjustable speed, effective and simple control of torque, acceleration and deceleration. Even with limitations of a commutator they can and do handle tough duty cycles.

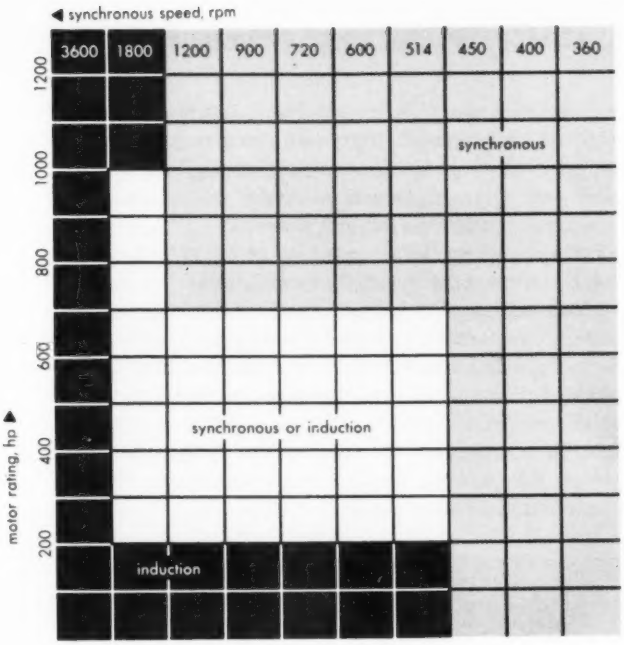
Yes, the dc motor is growing rather than slipping. Need for critical speed adjustment in continuous processes often finds dc motors operated in tandem with speed of each unit changing proportionally over a wide range.

Speed can be adjusted in the dc motor in two ways. Armature voltage can be varied, or you can vary field current. In some cases, both are varied. Raising armature voltage speeds up the motor, raising field current slows it.

A few words about dc motor size: Rule of thumb says that maximum economical size is not exceeded as long as product of horsepower and speed is less than 1.5 million.

Voltage-wise, think in terms of 250 volts for units up to 250 hp, 600 v for 600 to 1000 hp, 700 or 900 v above 1000 hp.

Where do you get the dc voltage? A close tally today shows that 95% of all dc motors operate from ac systems, through conversion equipment (see pp 120, 121).



Synchronous or induction?

One of today's big motor questions is when to use a synchronous unit and when an induction. Here's the thinking.

Synchronous motors *can* be used for any application a NEMA design-B squirrel-cage will handle. But whether a synchronous *should* be used is another matter. Cost-wise, here's a handy rule: Synchronous motors are less expensive than squirrel-cage if rating exceeds 1 hp per rpm. But this doesn't take into account the higher power factor and efficiency of the synchronous motor. These two factors alone are mighty important in low-speed motors (450 rpm or less), where pf and efficiency of squirrel-cage motors are poor.

For especially low starting kva, when controllable torque, kva or variable speed is wanted, either a wound rotor or a constant-speed motor and slip coupling may be used. Power factor and efficiency of today's 3600-rpm squirrel-cage motors are good. And this holds too for 1800 rpm. So unless pf improvement is especially important, squirrel-cage motors are logical first choice. But rarely will you find induction motors doing a good job below 500 rpm because of low pf and efficiency; synchronous motors, with leading or unity pf, show good efficiencies down to 72 rpm.

What about leading-power-factor motors? They're generally less efficient than unity-pf. But they do double duty. Use them in your plant when: (1) you need power-factor correction (2) you want motors to handle exceptionally high starting, pull-in or pull-out torque.

summary of motor characteristics and applications

dc and single-phase motors

Speed Regulation	Speed Control	Starting Torque	Breakdown Torque	Applications
SERIES				
Varies inversely as load. Races on light loads and full voltage	Zero to maximum depending on control and load	High. Varies as square of voltage. Limited by commutation, heating line capacity	High. Limited by commutation, heating and line capacity	Where high starting torque is required and speed can be regulated. Traction, bridges, hoists, gates, car dumpers, car retarders
SHUNT				
Drops 3 to 5% from no load to full load	Any desired range depending on design, type of system	Good. With constant field, varies directly as voltage applied to armature	High. Limited by commutation, heating and line capacity	Where constant or adjustable speed is required and starting conditions are not severe. Fans, blowers, centrifugal pumps, conveyors, wood and metal-working machines, elevators
COMPOUND				
Drops 7 to 20% from no load to full load depending on amount of compounding	Any desired range, depending on design, type of control	Higher than for shunt, depending on amount of compounding	High. Limited by commutation, heating and line capacity	Where high starting torque and fairly constant speed is required. Plunger pumps, punch presses, shears, bending rolls, geared elevators, conveyors, hoists
SPLIT-PHASE				
Drops about 10% from no load to full load	None	75% for large to 175% for small sizes	150% for large to 200% for small sizes	Constant-speed service where starting is easy. Small fans, centrifugal pumps and light-running machines, where polyphase is not available
CAPACITOR				
Drops about 5% for large to 10% for small sizes	None	150 to 350% of full load depending on design and size	150% for large to 200% for small sizes	Constant-speed service for any starting duty and quiet operation, where polyphase current cannot be used
COMMUTATOR-TYPE				
Drops about 5% for large to 10% for small sizes	Repulsion-induction, none. Brush-shifting types, 4 to 1 at full load	250% for large to 350% for small sizes	150% for large to 250% for small sizes	Constant-speed service for any starting duty where speed control is required and polyphase current cannot be used

2- and 3-phase motors

Speed Regulation	Speed Control	Starting Torque	Breakdown Torque	Applications
GENERAL-PURPOSE SQUIRREL-CAGE (Design B)				
Drops about 3% for large to 5% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	150% of full load for 2-pole to 105% for 16-pole designs	200% of full load	Constant-speed service where starting torque is not excessive. Fans, blowers, rotary compressors, and centrifugal pumps
HIGH-TORQUE SQUIRREL-CAGE (Design C)				
Drops about 3% for large to 6% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	250% of full load for high-speed to 200% for low-speed designs	200% of full load	Constant-speed where fairly high starting torque is required infrequently with starting current about 550% of full load. Reciprocating pumps and compressors, crushers, etc.
HIGH-SLIP SQUIRREL-CAGE (Design D)				
Drops about 10 to 15% from no load to full load	None, except multi-speed types, designed for 2 to 4 fixed speeds	225 to 300% of full load, depending on speed with rotor resistance	200%. Will usually not stall until loaded to max. torque, which occurs at standstill	Constant-speed and high starting torque, if starting is not too frequent, and for high-peak loads with or without flywheels. Punch presses, shears, elevators, etc.
LOW-TORQUE SQUIRREL-CAGE (Design F)				
Drops about 3% for large to 5% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	50% of full load for high-speed to 90% for low-speed designs	135 to 170% of full load	Constant-speed service where starting duty is light. Fans, blowers, centrifugal pumps and similar loads
WOUND-ROTOR				
With rotor rings short-circuited, drops about 3% for large to 5% for small sizes	Speed can be reduced to 50% by rotor resistance. Speed varies inversely as load	Up to 300% depending on external resistance in rotor circuit and how distributed	300% when rotor slip rings are short circuited	Where high starting torque with low starting current or where limited speed control is required. Fans, centrifugal and plunger pumps, compressors, conveyors, hoists, cranes etc.
SYNCHRONOUS				
Constant	None, except special motors designed for 2 fixed speeds	40% for slow- to 160% for medium-speed 80% pf. Specials develop higher	Unity-pf motors 170%; 80% pf motors 225%. Specials up to 300%	For constant-speed service, direct connection to slow-speed machines and where power-factor correction is required

Open enclosures handle most of industry's current requirements

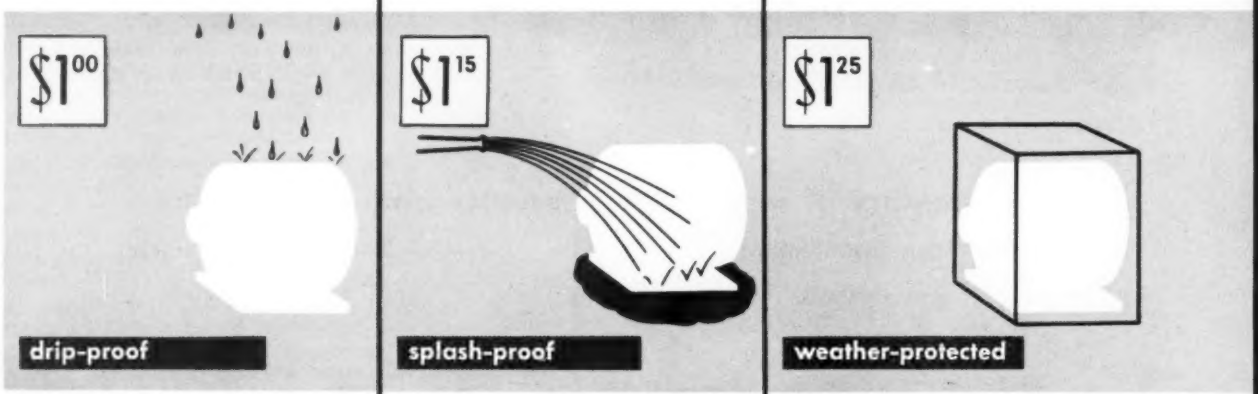
For virtually all motor types a wide variety of enclosures are available. These aim to protect against different ambient conditions, reduce maintenance, increase reliability and safety.

Open motors draw outside air through vent openings. It passes over and around windings, cooling them. So use open motors only where air contains nothing that would harm insulation. A certain amount of "normal" dirt can be tolerated.

All open motors have some form of enclosure, varying in size, location and shape of vent openings. Drip-, splash- and weather-protected motors discussed below are most popular of many types. In these, the enclosure design is intended to protect the motor and its windings.

In a "guarded" motor, the vent openings are restricted and located to prevent accidental insertion of hand or fingers into working parts. In a "semi-guarded" motor, restrictions apply only to part of openings, usually on top half of motor.

Textile industry fights against its lint problem by using totally enclosed nonventilated designs in smaller ratings. For larger ratings, many plants now use "textile motors" — specially designed open units with smooth surfaces and well-rounded corners to allow lint to pass through the machine without collecting in the vent passages. Some users put screens over the vent openings of standard open motors, but this can cause trouble unless screens are inspected regularly and kept clean.



Today's common industrial motor is of open design with drip-proof enclosure. This is defined by NEMA as one with vent openings so constructed that drops of liquid, or solid particles, falling on the machine at any angle not greater than 15 deg from the vertical cannot enter the machine directly, or by striking and running along horizontal or inclined surfaces.

Least expensive, drip-proof construction is suitable for clean indoor areas — elevator penthouses, etc.

For more protection, splash-proof enclosure is designed so drops of liquid or solid particles falling on the unit, coming toward it on a straight line, or at any angle less than 100 deg from vertical cannot enter directly, or by striking and running along surfaces.

This design is intended for motors operating under fairly severe moisture conditions. Manufacturers have offered them, and some plants have used them, for outdoor operation, but trend now is to weather-protected enclosure.

This low-cost open design for outdoor operation has side openings through which air travels up into space above stator. Rotor fan draws air from this chamber through motor windings. Heated air discharges through stator vents and out through screened, baffled openings in the base. This tortuous air path keeps dust, rain, snow out of windings, even when winds are high.

These units have been used down to –40 F with thermostatically controlled immersion heaters in oil reservoir.

Weather-protected units prove highly satisfactory answer for outdoor installations

Growth of outdoor installations in chemical and petroleum industries, and in power plants, brought need for a motor that would lick weaknesses of splash-proof type and yet be less expensive than enclosed designs. The weather-protected enclosure is the answer; experience to date is good.

Ambient air flows through windings to carry away heat, as in other open types, but designers have skilfully combined baffles, sharp turns, vertical and low-velocity travel so air reaching windings doesn't carry rain or snow.

Many on-the-job tests show these units stand up well, even against rain and snow driven directly into openings by high winds. Engineers now apply them for vertical as well as horizontal mounting; both types are available.

Is the weather-protected enclosure the last word for outdoor jobs? Probably for most. But ambient air does pass over windings, so corrosive atmospheres can cut life. And where hazardous conditions are met, an enclosed motor must be used — pipe-ventilated or explosion-proof.

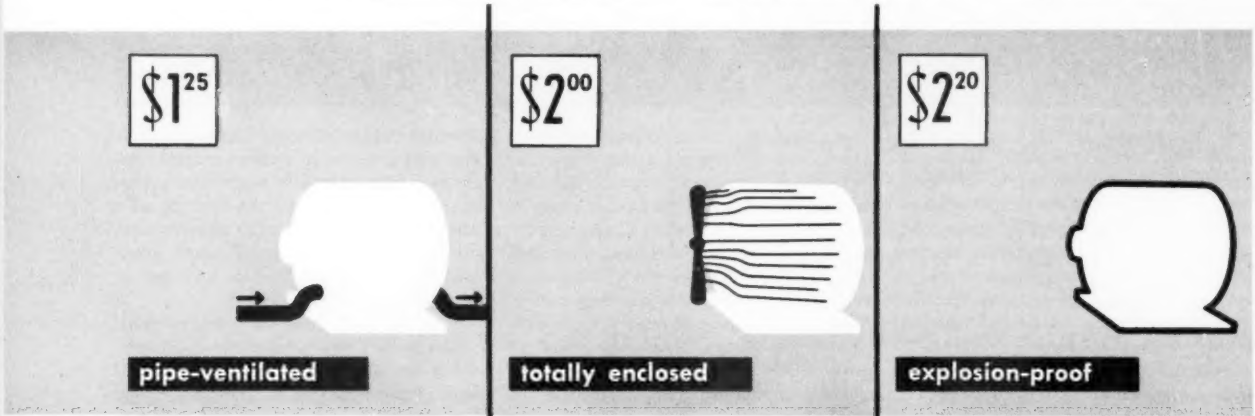
Totally enclosed designs cut maintenance, meet tough ambients

In most industries, trend is to a greater degree of enclosure to: (1) assure maximum motor life by protecting insulation (2) cut down motor maintenance.

Standardization. Many plants standardize to some extent on TEFC motors. But there's no agreement on whether it pays to settle on one motor enclosure, across the board. A majority seems to feel that economics calls for matching enclosure to particular need. Most plants thus wind up with at least several of available types. The exceptions, notably automotive plants, find standardization cuts maintenance and vastly reduces stock of spares needed.

Widely used "enclosed" types are discussed below. A number of special types are also of interest: (1) The *water-cooled* enclosed motor, with water-to-air heat exchanger, handles problems of high ambient temperatures. (2) The *sanitary* motor, totally enclosed, nonventilated and water-proof, has a smooth, crevice-free exterior that can be easily cleaned of germ-bearing dirt. (3) The *chemical* motor is a TEFC design with special emphasis on impregnation and insulation of windings, etc.

"Price tags" below show *relative* costs of several enclosure types, taking the common drip-proof as $1.00. Comparison is for 1000-hp 900-rpm 2300-v 60-cycle 3-phase motor. Values change in smaller sizes, where, for example, weather-protected and pipe-ventilated types aren't widely used. In the 50-hp range, splash-proof would be $1.10, TEFC $1.65, and explosion-proof $1.85 (using same base).



A pipe-ventilated machine is totally enclosed except for inlet and outlet duct openings. Connecting ducts admit and discharge ventilating air, which is circulated by a fan within the motor enclosure, or, in many cases, by an external blower.

This *separate-* or *forced-ventilated* type is applied if surrounding conditions don't supply enough clean, cool air. This type of application is of growing importance in the petroleum and chemical industries.

The totally enclosed fan-cooled motor (TEFC) has a fan at end of motor shaft to circulate air around its totally enclosed motor frame. Cooling efficiency is increased by placing fins on exposed side of the inner frame. Then an outer shroud is placed around complete motor and fan, enclosing all but the necessary vent openings.

This type is becoming more and more popular; in many cases, lower maintenance and greater reliability more than offset higher first cost.

This totally enclosed type is designed and constructed to withstand internal explosion of a specified gas or vapor and to prevent ignition of any gas or vapor surrounding the motor.

In applying explosion-proof motors, refer to the National Electrical Code, Article No. 500, Hazardous Locations Class 1, Group A, B, C and D.

This enclosure is costly, so today's engineers try to avoid need for it, either by changing motor location, or by using a pipe-ventilated enclosure.

Pipe-ventilated motors find economical application in industry's hazardous areas

In a never-ending search for lower-cost methods, engineers now seek to avoid heavy cost of explosion-proof enclosures, particularly for large units. The pipe-ventilated design, pioneered in the petroleum industry and now used by others, looks like a good answer. Right now, for example, 600- to 1000-hp pipe-ventilated units smack in the heart of chemical or hazardous areas are working with cooling air brought to them through ducts from a source of clean air. Cost comparisons must include ducts and blowers. Where source of clean air isn't too far away, this scheme pans out economically.

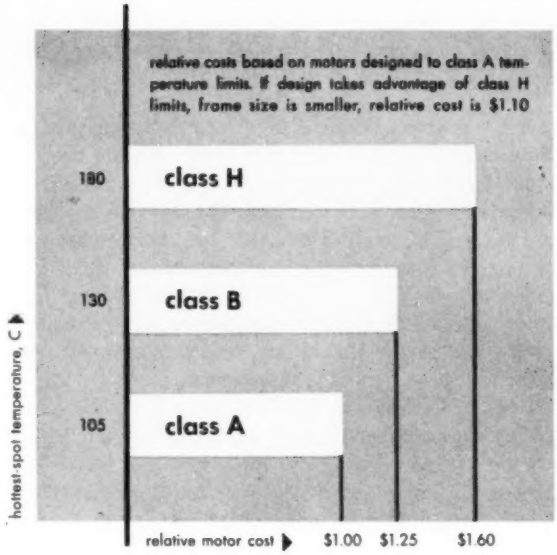
Another possible answer is the totally enclosed gas-filled induction motor. Basic idea of this type is to keep gas within enclosure at a pressure slightly higher than the surroundings. This insures against explosive gases seeping into enclosure. A recent example of such an installation is a 3000-hp 1800-rpm 2300-v 3-phase unit driving an oil-refinery centrifugal compressor. Keep this scheme in mind as a possible lower-cost solution to problems of hazardous or corrosive atmosphere.

1/c motors: insulation

Motor manufacturers snap up each insulation advance, always seeking materials with high dielectric and mechanical strength. They also look for resistance to oils, acids, alkalies, and, particularly, to high temperatures. And they must have a final product of reasonable cost.

User talk centers about thermal "endurability". Within rating limits, old standbys, class A and B, serve well. Even in face of new materials, over 90% of today's motors are being class-A wound.

Three reasons are usually given for slow acceptance of new H materials, and all are facing change: (1) Cost — manufacturers of class H are working to pull price into line with class A. (2) Reported physical problems of applying — these seem to result largely from lack of familiarity and are being corrected. (3) Human inertia — this tends to disappear as engineers learn where and how new materials stretch motor life, cut maintenance.



class A

Basic ingredients are: (1) cotton, silk, paper and similar organic materials impregnated or immersed in a liquid dielectric (2) molded or laminated materials with cellulose filler, phenolic resins and other resins with similar properties (3) films and sheets of cellulose acetate and other cellulose derivatives (4) varnishes (enamels) applied directly to conductors.

Class A finds widest use in small and medium motors. Minimum life expectancy is 7 yr when operated at 105 C. Remember this general rule: Life expectancy halves for each 8 to 10 C increase in temperature. Also remember: Operating temperature is that of hottest spot in motor — anywhere from 10 to 15 C higher than that measured by thermometer at winding or magnetic core.

class B

This includes mica, asbestos, glass fibers, and similar inorganic materials in built-up form, with *organic binding substances*. A small portion of class A material may be used for structural purposes only. But where so used, electrical and mechanical properties of insulation must not be damaged when temperature reaches top value allowed by class B. Experience shows temperature endurance of different class B materials varies widely depending on percentage of class A materials used, and degree of dependence placed on organic binder for maintaining structural integrity.

Use of Class B is growing in large motors, and among "specials" such as railway and steel-mill motors. Life expectancy is 7 yr at 130 C. Remember: Temperature rises as square of current.

class H

This newcomer is simply class B insulation with a binder of silicone compounds or other materials with equivalent properties. Or, it may take the form of silicone compounds or similar materials in rubbery or resinous form. Plastics, even synthetic fibers like Dacron, now get a whirl as electrical insulators.

Boasting an allowable hottest-spot temperature of 180 C (even though Navy specs list 200 C as allowable), class H finds increasing use in jobs involving high ambient temperatures and extreme duty cycles or load conditions. What life can be expected? Latest tests indicate at least 7 yr of continuous operation at hottest-spot temperature of 220 C is needed to reach minimum thermal life. At the more modest level of 180 C, test data show a life expectancy of 60 yr.

Where and how would high-temperature insulation pay off in your plant's motors?

Advent of class H insulations tends to put emphasis on resistance to high temperature. This is mighty important, but remember a good insulation has other qualities, outlined above. Make sure you come up with a well-rounded answer.

Class H enters its own, as you might expect, where high operating or ambient temperatures can't be avoided. Example: Work schedules in a large foundry forced an overhead crane to make more, shorter trips. This kept it closer to the furnace. Heat actually limited life of overworked crane motors to about 20 days. Space limits ruled out larger units. By rewinding with class H, the three motors, rated 15, 30 and 50 hp, have stood up for over 2 yr to date. This rewinding cost about $370 more than if class B had been used.

Across industry today, class H is being used to advantage in many places . . . where overloads are responsible for frequent outage . . . where high ambients limit life of class A or B motors . . . where rapid reversing causes frequent and premature failures . . . where motors give trouble because of excessive moisture . . . where cost of downtime is prohibitive.

Many of these class H applications are like human use of miracle drugs. After trouble symptoms flare, we turn to them for rescue — and they do the job. But many times, advance planning would keep the emergency from arising.

An era of "hot" motors — is that what we're moving into now that high-temperature insulations are here? Hardly. Operating men shy away from working accessible motors at top temperature limits. The full temperature advantage of class H will, in general, be realized only where space is at a mighty high premium or ambient conditions largely dictate operating temperature. Keep in mind that it isn't only insulation that must stand high temperatures — so must bearings and lubricants. Silicones are likely to come to the rescue here, too.

1 **Adjustable-speed drives** find ever wider use as an important tool for speeding production, making better use of each machine as designs and models change.

2 **Power sources** for many drives still use ward-leonard system but with modern refinements. All-electronic schemes are also used.

3 **Automatic regulation** of machines through feedback control systems gains in importance as "continuous-process" idea grows.

4 **Magnetic amplifiers** — simple, rugged, easy-to-maintain — are making significant contribution to automatic regulated systems.

Need to get the most out of each production machine puts emphasis on industrial motor-control systems. And success of any major move to automation hinges on continued improvement of electrical control.

Two broad types of control are: *unregulated* or *non-feedback*, and *regulated* or *feedback*. In unregulated systems, discussed below, control may be manual or automatic but is not a function of load. This contrasts with regulated systems described on next two pages, where the regulating signal is an impulse received from the load.

A feedback regulating system (1) *measures* the controlled variable (2) *compares* magnitude of the variable with a reference input which is the desired value (3) *amplifies* the operating signal so control elements may produce a big-enough correction.

Among unregulated adjustable-speed systems, the more-than-50-yr-old ward-leonard method still serves well. A modern touch has been added: many of the control features are handled electronically.

Automatic regulation, growing in use as the continuous-process idea expands in industry, is served by four basic schemes. Now the magnetic amplifier holds the limelight. But remaining three schemes — rotating amplifier, all-electronic and electro-mechanical — will continue to serve, since each has features of cost, size, or speed of response that make it particularly adaptable to some specific problem.

Even in simpler forms, adjustable speed promises higher output

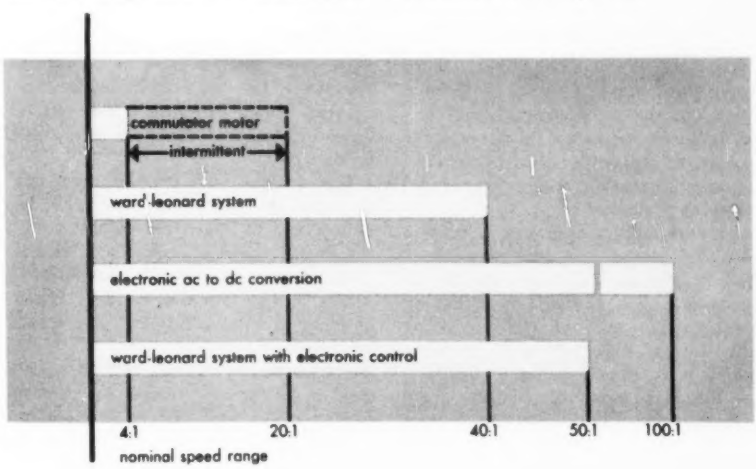
Some engineers feel an immediate 10% boost in machine output would result if all constant-speed machines that could profitably use adjustable speed were changed over. The figure can be questioned, but not the idea. Industry as a whole is fast realizing the potentials of adjustable speed. Payoff generally comes in: (1) bigger variety of goods produced faster (2) fewer machines needed for a wider range of operations.

Simple dc motors form a broad base for the whole electrical adjustable-speed picture. They aren't bowing out, as we used to think, but find new uses because of hard-to-beat speed-variation features. Where a dc source is readily available, desired speed variation can be had through field or armature control. While in today's plants a readily available source of dc is still the exception, modern rectifying equipment (pp 120, 121) makes conversion easy.

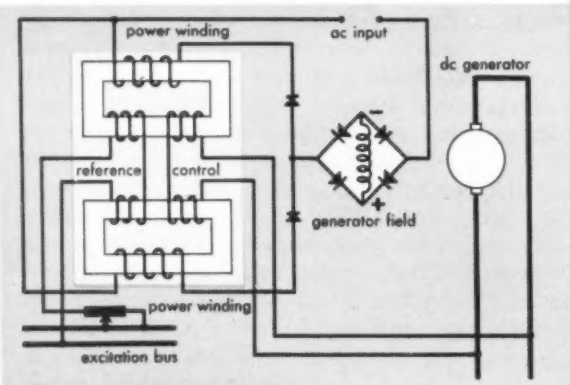
With dc on tap, or with adjustable-speed ac motors fitted with control components, stepless speed variation during operation is readily possible.

Applications. A number of relatively simple control systems, not employing automatic feedback regulation, will handle a variety of industrial jobs. Desired speed may be preset or manually regulated. Typical are machine-tool drives, where speed adjustment compensates for differences in materials and depth of cut. Often a 4:1 speed range is adequate.

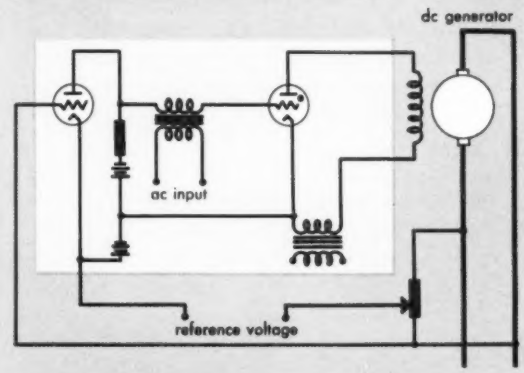
Crane, hoist and elevator drives call for not only a wide speed range but also fairly accurate speed settings in face of widely varying torque demands. Planers and reversing mills are applications where a big premium is placed on minimum reversing time. Actual speeds may be preset, as on planers, or controlled by an operator, as on blooming mills. In both cases a wide speed range is needed, often as much as 40:1. Boiler draft fans are another familiar example of adjustable-speed drive. They may be adjusted manually, but in modern plants are more apt to be regulated by the combustion-control system.



Automatic feedback regulating systems give precise, wide-range . . .



magnetic amplifier



electronic

This truly simple device for amplifying voltage and current has three elements: rectifier, wire, magnetic steel. Basically, it's a way of putting variable impedance in an ac circuit. Dry-type rectifier, in series with load, converts amplifier's ac output to dc, fed to a motor or generator field.

With control winding inactive, load current is restrained from flowing through load by high impedance in magnetic amplifier. This is very high when core is magnetically unsaturated. But when saturated, amplifier impedance drops way off, allowing load current through.

Amplifier action thus centers on control of core's magnetic saturation. And that's what the control winding accomplishes. For instance, when no power is to be delivered to the load, it's only necessary to apply just enough current to control winding to assure that magnetic flux level never gets to saturation. And to deliver any particular level of power to the load, it's only necessary to "reset" magnetic flux to an appropriate level by changing control current. Amplification comes about since actual power needed to reset magnetic core is minute compared to power voltage delivers to load.

In contrast to a magnetic core, this regulator uses vacuum and gaseous tubes to amplify. Surface disadvantages center about the unpredictable life of components. But electronic regulators handle jobs that would be tough for other units. They can operate from weak signals and can be built for high gain and fast speed of response. This combination means they can regulate to greater precision if need be. And electronic regulators are flexible, readily lending themselves to tough circuit requirements.

Even though gain and speed of response exceed those of the magnetic amplifier, the latter fills most needs in the power field, where high gain and fast response are not generally required. No doubt, too, human nature has had a hand in holding back some applications — an aura of mystery still surrounds electronics among the uninitiated. And some operating problems with tubes, capacitors, etc, were reported.

Typical of applications these units have found are those in the steel industry. Here, some regulators must "see" and photoelectric cells are used in the control circuit. In rod mills, precise and fast-acting regulation is vital.

Simple and rugged magnetic amplifiers loom large among regulating devices able to . . .

The magnetic amplifier will play a significant part in industry's march toward automation. Crystal gazing? Hardly. Theory of the magnetic amplifier has been known for years. Its appearance as a "new" regulating device grows out of recent improvements in magnetic and rectifying materials.

Regulators hold a key spot in today's industrial scene. Let's look at some of the jobs they do. Regulators are largely responsible for present operation of tandem rolling mills at 7000 fpm, paper machines at 2500 fpm and machines spinning man-made yarns at 6000 fpm. Just ten years ago, these figures were 3500, 1500 and 1500 fpm for rayon, only synthetic fiber at that time. Yet quality of product isn't being sacrificed; in fact it's usually improved. Most important: Number of men needed to operate a processing line or machine doesn't go up with speed, so higher speed means lower unit labor costs and hence lower product cost.

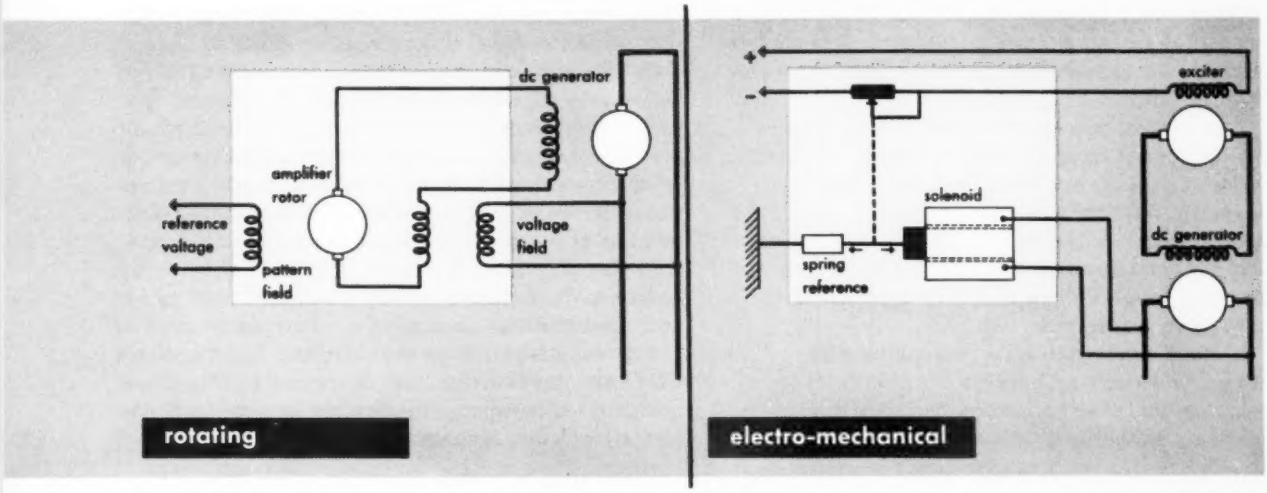
Speed alone isn't enough. Accuracy is essential. Cold-rolled steel must be held within ± 5%, paper within ± 4%. If they are to dye successfully, diameter of synthetic-yarn filaments must be held within ± 1%. At the same time, many of these processes demand that speed be held to ± 1/10th of 1%.

Amplifier Requirements. To rate a nod from industry, an amplifier for control, like any electrical unit, must pass inspection on several counts. First, it must be simple, easily understood by the plant men who have to live with it. It must be rugged and reliable, capable of foolproof service for many years. Maintenance needs must be pared to barest minimum. Unit must do its job from the beginning without long and tedious adjustments by factory experts.

From where we stand today, the magnetic amplifier rates high on all these points. It has no bearings, commutator, brushes, electronic tubes, or moving parts. Field experience so far shows that the few simple adjustments made at time of installation generally last.

Potential applications pop up at almost every turn in the growing maze of industrial-drive systems and special controls. Right now magnetics are being used to regulate such quantities as

. . . fast-response control required for today's continuous processes



The amplifying medium here is a rotating dc machine — basically an adaptation of a ward-leonard control system consisting of a motor-generator set and a driven motor. The generator is a special design giving a high degree of amplification. One type (not shown) has field exciting short-circuited armature. Armature current sets up cross-magnetization much higher than the normal field. A second set of brushes, set 90 deg from the normal short-circuited brushes, delivers power proportional to cross-magnetization. In some designs, amplification from field-circuit input to armature output is 10,000 to 1.

This scheme has served for regulating jobs calling for a wide variation in speed combined with precise speed control. Accuracy is limited by motor inertia. Inherent ability to be reversed permits "forcing the fields", a technique used to kill fields rapidly. Many applications where rotating amplifiers were favored are now being handled by magnetics. But unique advantages — high power output circuits and ability to handle repeated reversing — keep rotating amplifiers in the running. Since they are basically rotating dc machines, their servicing is well understood by plant operating men.

Solenoid or torque motor is at heart of this regulator. Unit converts electrical signals into mechanical motions which, in turn, change resistance in field circuit of the machine controlled. As sketched above, the reference is a spring and linkages. In combination, they form a fixed mechanical bias for the regulator. Signal is voltage from regulated source.

This voltage supplies power to the solenoid. Its pull balances pull on reference spring. This means a small change in solenoid ampere-turns can swing the regulator over its entire range. Solenoids generally used have a straight-line plunger motion but some use a rotary motion. Application shown above has the regulated variable resistor in the shunt field of the machine being controlled.

The well-known rocking-contact-type voltage regulator falls in this class. Here the job is usually to maintain constant output voltage of a generator. The generator voltage is the signal applied to the solenoid coil. The general drawback to this type of regulator is that control is stepped, rather than infinitely stepless as in other systems. Its big advantage, and a real one for some jobs, is low first cost.

. . . control any factor of machine output that can be translated into a signal voltage

speed, voltage, wet tension, power, frequency and position. In short, any quantity that can be translated into voltage or current.

Major use of magnetic amplifiers is in speed regulation. Both tachometer feedback and counter-electromotive-force systems are used, according to the application and the accuracy desired. Tachometer feedback uses a pilot generator to cue the regulator.

Speed of a dc motor is proportional to the counter emf. Thus a counter emf regulator can be designed that uses current and voltage signals. Typical application is found on tandem mill in steel industry. Here the regulator forces various stands of the mill to operate in synchronism as the mill accelerates from standstill to operating speed. Counter emf of each motor is matched to a master or reference voltage. This reference voltage is increased when speed acceleration is wanted. And since the speeds at all stands are matched to the same reference, all remain in synchronism.

Voltage regulators such as are used on ac generators in central-station and industrial power houses, can use the magnetic amplifier principle. The problem of regulating an ac generator with a magnetic amplifier is really no different from regulating a dc generator, since ac signals can be converted easily to dc with dry-type rectifiers.

Magnetic amplifiers fit well in the trend to "packaging" and standardizing. This is a significant advantage over other regulating systems. Electronic amplifiers often require major alterations when used for different regulating jobs. Rotating regulator units may not include multi-purpose windings since space is at a premium. Usually, the magnetic amplifier has enough winding space to allow economical use of multi-purpose and extra windings.

Sole Survivor? Will the unique advantages of the magnetic amplifier mean the gradual disappearance of other regulating systems? Definitely not. This form of regulating device complements and extends each of the other systems, extending the range of control but not serving best in all applications. And it will bring the use of regulating methods into completely new areas of application.

2 centralized control

A modern control center consists of starters and associated equipment for motor control, together with interwiring and buswork, all housed in a steel cabinet ready for field installation. Then all that's needed is to run a feed to the control center and feeds from it to individual motors — plus any remote-control-station wiring required.

This central system contrasts with locating individual control units at each machine, or grouping motor-control equipment in a central spot by hand assembly of individual components.

Advantages. Centralized control offers: simplicity in planning and installation, compactness and neat appearance, high degree of safety, centralized operation and maintenance, flexibility.

In *fixed-connection* type, line connections of individual units bolt to busbars. In *plug-in* type, connections are made by clips which slide over vertical busbars, simplifying removal of individual units. Starters can have either circuit breakers or fuse-disconnect switches.

Anything from across-the-line starters to automatic transformer-type starting equipment can be built into control centers, as can lighting panels.

An all-aluminum control center is now available — 65% lighter than its steel-and-copper counterpart. It's pegged for food plants where cleanliness is paramount, chemical plants with corrosion problems.

Initial equipment cost of today's control centers generally runs higher than that of an equivalent number of separate starters. But total installed cost is apt to run less for the control center.

Location. Control centers may be put on the floor or in space between roof and lower structural members. Many engineers like control centers in separately ventilated rooms away from work areas. This often avoids need for special enclosures to resist hazardous or corrosive atmospheres.

Consider these factors to determine if centralized control is the...

Centralized motor-control units are far from a universal answer. You must determine whether they are best suited for your particular installation, or whether some form of local or group control is the best engineering bet.

How Permanent? One point to consider is the degree of "permanence" of your production equipment. Can the machines be expected to stay in their present positions for some years to come? If they can, and if they're closely grouped, the odds favor a centralized-control setup.

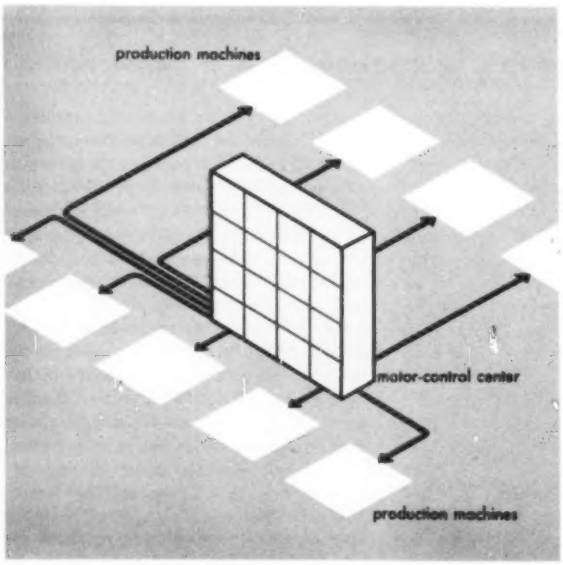
But in many industries it's reasonable to expect shifts in machine location from time to time. In the automotive industry, for example, machine locations shift as models change. Here, bus duct with individual motor starters at each machine is usual practice, to simplify moving machines.

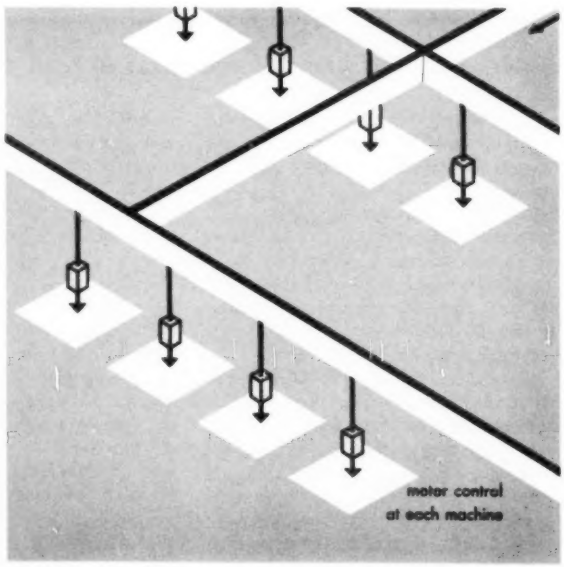
Individual motor starters fit well where machines are far apart and also where control is quite complex, with multi-speed equipment and much control wiring.

In adopting any system of centralized control, keep your eye on available short-circuit currents. A control center should not be connected to a system where available short-circuit current is greater than rating of the center. Available short-circuit current is that which would flow through a zero-impedance fault at the line terminal of the motor-control center.

Allowable short-circuit current rating assigned to a motor control center is 25,000 amp rms asymmetrical. Manufacturers brace the buswork to withstand this possible short-circuit current. But, in addition, short-circuit rating of a control center depends on the type of protective means used within each individual combination starter and whether or not the control center as a whole has an incoming-line circuit breaker.

When Is Line Breaker Needed? Where incoming short-circuit current is within 15,000 amp, no incoming-line circuit breaker is needed. And the combination starters can be molded-case

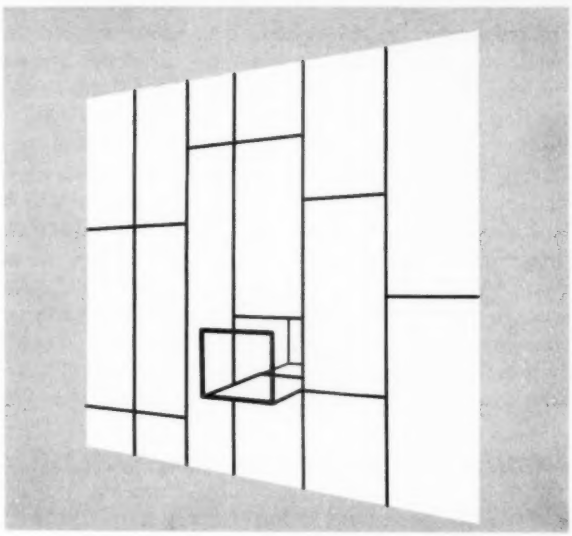




In another scheme, units are spotted on the machine floor, hooked up to an outside source of clean air. Pressure in control unit is kept slightly above that of the surroundings. This is particularly advantageous in dusty areas.

NEMA Types. There are three standard NEMA types: Type A is by far the simplest, having no terminal blocks and no wiring. Standard combination starters or circuit breakers are factory-assembled in the structure, connected to vertical buses. Motor and control wires connect direct to starter terminals.

Type B has individual terminal blocks in each starter. This makes it easy to install or remove starter, simplifies field wiring. Type C is completely factory wired, including Type B individual motor blocks. It also includes wiring to master terminal blocks either at top or bottom of the structure. This construction may include any sequence wiring or wiring required between starters.



...best bet for you. Then follow these steps to plan an installation

air breaker type, having a short-circuit rating of 15,000 amp.

But if up to 25,000 amp are available on short circuit, then an incoming-line air breaker with 25,000-amp interrupting capacity is required if molded-case air breakers are to be used in the combination starters.

One reason you can use this setup is that the internal impedance within the combination starters can be counted on to limit the short-circuit current within 15,000 amp, even though 25,000 amp are available on incoming side of control center.

Principal impedance in this setup comes from overload heaters. That's why it's mighty important to select molded-case air-breaker trip to coordinate with overload heaters. Circuit breaker must start to trip before overload heaters become so hot they are in danger of fusing.

If you decide that centralized control equipment is best for your needs, the first step is to calculate whether standard control centers available from one of the many makers will meet your short-circuit requirements. Keep in mind the limitation of 25,000 amp and find out if a figure beyond that is available at the point where you plan to tie-in to the feed. This is especially important if the control center is banked alongside a secondary unit substation, where short-circuit current can be of a high order of magnitude.

This may call for relocation of the control center, use of high-rupturing-capacity fuses on incoming side of the center, or, possibly, the use of reactors.

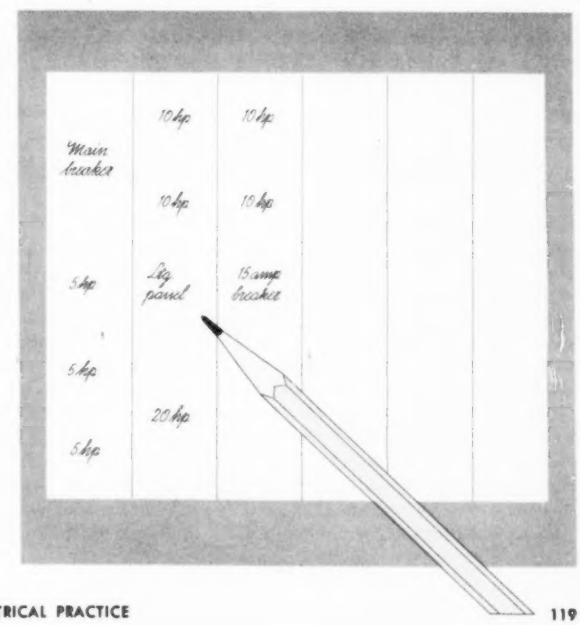
Next step is to jot down hp load and arrangement desired. This is indicated in sketch at right. At the same time, decide on some of the basic design considerations of the control center. For example, are you going to use bolted or stub-type disconnects? Also pin down your choice on molded-case air breakers vs fuses.

Third logical step in planning a motor-control center is to determine NEMA type. As outlined, these types differ in degree of completeness of the unit as furnished by the maker. This is something only you can determine, keeping in mind the installation cost involved if you choose Type A or B.

Many power engineers feel that Type B can be justified by slightly lower equipment cost compared to Type C. And in many cases, slight changes occur between time control equipment is specified and time of delivery. The interchange of motor-control units necessitated can be made more easily on Type B than on the completely prewired Type C.

List Accessories. At this stage it's also a good idea to list accessories and modifications that depart from standard equipment shown in catalogs of the control-center supplier. Although "specials" are often the logical answer to overcome local problems, strive for adoption of standard equipment throughout. Costwise it's always to your benefit to use standard designs. And it simplifies maintenance and repair later.

Then pin down location. Try to spot control centers in least-valuable areas — where machines can't be fitted, in roof structure, or in a separate control room. This last is often best in industries such as textile and steel where ambient conditions may require special enclosures to resist hazardous or corrosive atmosphere. Keep in mind that control centers can be lined up in a straight row, put back to back, or arranged in L-shaped or U-shaped layouts.



3 sources of dc

Industrial applications of dc grow, not only among past big users like steel and aluminum but also in general. Reason: To meet needs for degrees of speed variation to be had only in dc motors.

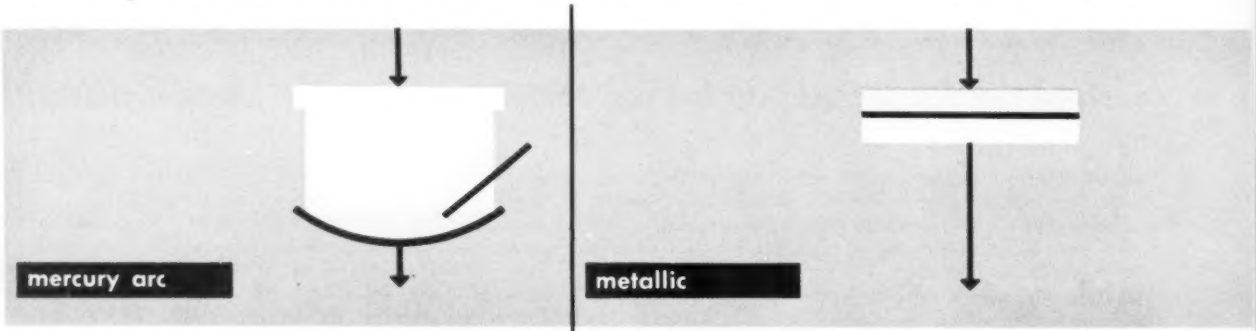
Recent thinking favors a number of dc conversion points close to load centers, with short dc secondaries, instead of central conversion. And equipment follows the modern "packaged" theme. For sizeable applications, the package is a full-fledged unit substation, with an ac circuit breaker, step-down transformer, dc conversion unit, dc main breaker and smaller dc feeder breakers.

Static rectifiers, with high over-all efficiency and low maintenance, get the call for many of today's jobs. In steel mills, for example, mercury-arc units are major source of 250-v dc and also appear to be taking over on main drives of continuous mills. But where reversing and variable speed are needed, as on blooming mills, mg sets still serve best.

Four basic conversion units outlined below have their special virtues but there are areas of "overlap" – where more than one will do the job reasonably well.

Selection. First consider load "geometry" and then its electrical characteristics: voltage, current, etc. Need for widely variable voltage might point to an mg set. A heavily fluctuating load with frequent severe overloads might favor rectifiers. So would sizeable periods of no load or light loads; rectifiers have relatively low no-load and partial-load losses.

In today's load-center-located ac-dc conversion station, static . . .



Before 1937, all commercial mercury-arc rectifiers were of multi-anode type, with 6, 12, or 18 anodes per tank. Coming of the more-efficient single-anode type (first the *ignitron,* then the *excitron)* broadened applications in lower voltage range – 200 to 300 v. The pumpless tube pushed practical usefulness to still lower ratings.

Ignitron's distinguishing feature is a small stationary electrode immersed in cathode mercury pool. This ignitor starts the cathode spot. Once established at mercury surface, main anode can pick it up and conduct in one direction.

Method of creating cathode spot differs in the excitron. While rectifier operates, a pilot arc from the excitation anode continuously maintains spot on the mercury surface.

Basic elements of any metallic rectifier are a good conductor and a poor one *(semi-conductor),* with a barrier layer. Current flows more readily from semi-conductor to good one.

Advantages are: ruggedness, no filament excitation, no time delay, long life, high efficiency. But metallics are likely to cost more than tubes, show poorer voltage regulation and lower efficiency at high voltages. They lack grid control, weigh more, take up more space.

Today's metallics include magnesium-copper sulfide, copper sulfide, copper-oxide, selenium. Germanium, a newcomer, is now available in units rated to 25 kw at 125 v. Metallic rectifiers find use in battery charging, resistance welding. They supply dc for small motor loads in increasing number.

Sealed or pumpless mercury arcs gain wide acceptance for small, medium loads

Simple, reliable and easy to maintain, sealed or pumpless mercury-arc units are gaining wide acceptance on small to medium loads (750-1000 kw).

Typical unit in metal-enclosed cubicle comprises a number of sealed tubes or tanks, associated excitation equipment and accessories. Tubes are evacuated, degassed and sealed at the factory. This eliminates vacuum connections, equipment for maintaining and indicating vacuum, cuts maintenance.

Tubes are water cooled. After passing through tank jackets, water goes to a heat exchanger before recirculation. Raw water flowing through exchanger to drain carries away the heat. Direct cooling by raw-water supply is also employed. Where water is scarce, water-to-air exchangers can be used.

Performance. How long do tubes last? Roughly five to seven years if properly applied and operated. Manufacturers generally guarantee for two years on a prorata adjustment basis.

In general, the sealed mercury-arc rectifier will now show about 7% better full-load efficiency than an mg set. This will vary to approximately 19% at quarter load on 600-v service. For 250-v service, efficiency curves still show a strong advantage for mercury-arc units compared to mg sets.

But pumpless mercury units have inherently lagging pf. In contrast, an mg set boasts pf between unity and 80% leading. Watch this if your utility contract has a pf penalty clause. At full load and rated voltage, a pumpless rectifier will run about 87% lagging. A bank of capacitors (230 kvar for 1000 kw) would raise this to 95%.

Be sure to consider ambient conditions, space requirements, and those ever-present factors — first cost and operating cost.

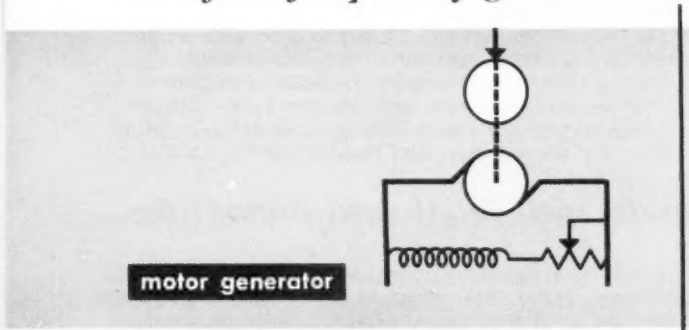
Essential Services. In reduction of manganese, power outages of more than a few seconds can't be tolerated. While not necessarily this critical, many other dc services must be protected against interruption. Possible answers: (1) separate ac feeds (2) duplicate conversion equipment. Both also help during scheduled maintenance shutdown. But what if economics won't justify cost of additional units? Then use single-pole high-speed anode switching to isolate individual tanks or tubes of mercury-arc unit. This keeps it on line in spite of an arcback or failure in one tank.

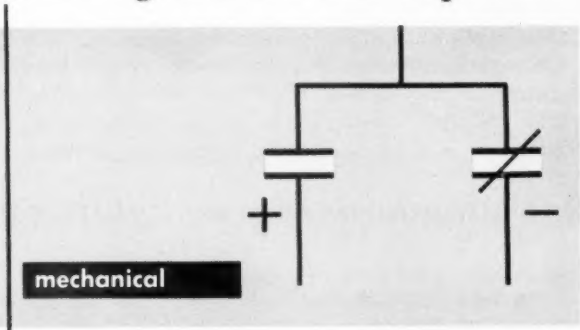
Magnetic amplifiers are coming into conversion picture, particularly above 600 v. A small unit can provide an output proportional to dc current, hence measure it without taking high-voltage dc to the board. Similar idea can be used for volts, watts, watthours.

How rectifiers work

Look on today's rectifiers as selective electric valves. They allow only the positive portion of an ac wave to flow through to the positive side of the dc bus. The negative wave is either completely blocked (half-wave rectification) or fed to the negative dc bus (full-wave rectification). The full-wave rectifier thus uses both sides of the incoming ac voltage wave.

...rectifiers frequently get the nod, but mg sets are still important





In spite of advances in the rectifier art, and growing application of static units, mg sets still handle a good bulk of the load. Big reason: An mg set can deliver anywhere from zero to maximum voltage. In general, voltage variation is obtained by changing field strength of generator. Any reasonable voltage can be had by taking advantage of the characteristics of shunt, over- or under-compounded connections.

Ambient conditions — temperature, dust, humidity, hazardous atmospheres — are important for mg sets. Temperature by itself is a limiting factor in insulation life, but modern insulations (p 42) have this licked; Class H to 180 C. Various types of enclosures (pp 40, 41) cope with problems of water, hazardous atmospheres and explosive conditions.

Mechanical rectification was introduced in this country just after World War II, and there are still only a limited number of units in operation. The rectifying element is a set of metallic contacts driven by a synchronous motor. These close when ac sine wave is in desired direction, break contact when ac voltage reverses. In other words, it is a motor-driven switch, connecting and disconnecting ac and dc systems in synchronism with sinusoidal variation of ac.

Major problem is to open and close contacts only when ac wave is passing through zero, to minimize wear on contacts. This is now done by using a saturable or "commutating" reactor inserted between transformer terminals and ac bus. This stretches the zero-current time of the ac wave.

With top efficiency promised, development of mechanical rectifiers goes ahead

Efficiency is the big reason industry watches development of mechanical rectifiers. Values of 94 to 97% (over-all, ac to dc bus) are recorded. This is a major consideration where dc loads are heavy, as in electrochemical plants.

Mechanical units handle fluctuating loads between limits but are critical on overload. Normal voltage span of today's units is 5- to 400-v dc. Current ranges between 1500 and 10,000 amp; units are paralleled for larger loads.

Any fixed voltage drop penalizes rectifier efficiency increasingly as voltage is lowered. Mechanical rectifiers have no constant voltage drop anywhere from ac to dc bus. That's a reason for slanting to applications under 400 v.

Fine voltage control can be had, with quick response. Two methods are used. One regulates supply voltage with an induction regulator or transformer tap changer. Second method, known as phase shift, delays point in ac wave where commutation starts. Rotating the stator of the synchronous drive motor does the job. Usual practice changes supply voltage for course regulation, with phase shift for close adjustment.

Two limitations are: (1) Unit can't stand a current reversal to rectifier itself. (2) If ac feed is lost, unit will shut down and some of silver contacts will generally need replacement.

Today's maintenance problems center about the main silver contacts. Available figures peg maintenance at about 1½% of total rectifier cost spread over a 5-year period. If the drawback of short contact life can be licked, as now seems indicated, we'll have another major rectifying device to serve industry.

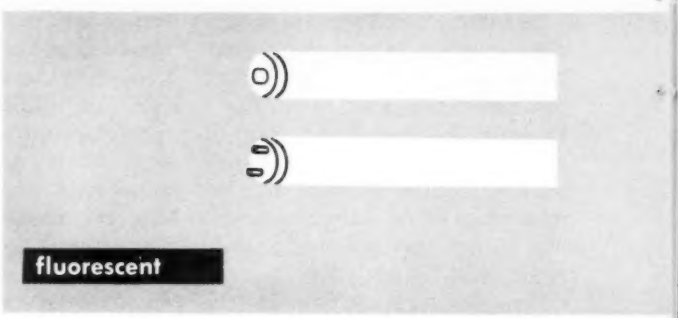
4 industrial lighting

Today's clear trend toward good, comfortable industrial lighting stems from these reasons: increased personal efficiency, less spoilage and hence more production, safer conditions, lower labor turnover. And need for good lighting won't disappear in the "automatic" factory. There it will speed the topnotch inspection and maintenance that will be needed to reduce downtime of expensive machinery.

Steady progress of illumination engineers makes first-class lighting ever easier to obtain. Today's fixtures give right emphasis to "upward" light, are easier to maintain. In some cases, the job can be done right from the floor.

New and improved light sources (see panel at right) also play a part. An important newcomer is the color-improved mercury-vapor lamp. High-frequency fluorescents, giving greater efficiency, may soon come out of the laboratories. Filaments continue as the light source lowest in first cost.

Changes in lighting-circuit layout also take shape. Forward-looking power engineers now consider higher voltages, notably 277 v. This is line-to-neutral voltage on a 480-v secondary distribution system.



fluorescent

Most used now and in foreseeable future, fluorescents boast relatively low brightness and efficiencies running 2 to 3 times that of filaments; output roughly 60 lumens per watt. Low intensity means many units and a uniform spread-out light source. But fluorescents have highest installed and maintenance cost of all sources. Expected life is 7500 hr.

Usual maximum height is 25 ft, but plastics and aircraft industries use high-bay fluorescents to cut reflection.

Slimline lamps, in 6- and 8-ft lengths, prove popular. Reasons: instant starting, no starters, fewer lamps needed.

Cool fluorescents give outdoor-like light; *warm* approach filaments. *Standard* lamps have highest efficiency, reasonable color rendition; *deluxe* have lower efficiency, excellent color. Most plants find standard cool-white lamps suitable.

With standards of good lighting pretty well set, the emphasis now...

Industry today pretty well agrees on what constitutes good lighting, the bible being the IES (Illuminating Engineering Society) recommendations. Best practice gives prime consideration to good general lighting, with supplementary lighting for machine and work areas. Hand in hand with this goes careful section of paint colors for walls and equipment.

Fixture Design. Comfort and high efficiency keynote today's fixtures. Proper shielding eliminates glare (reduction of shiny work surfaces also helps). Designs provide upward light component so area above fixture is lighted as well as work area below. Ventilating openings at fixture top give "chimney" action to carry dirt particles up and clear of fixture.

General trend is away from high-intensity sources, toward low brightness over larger lighting areas. In offices, troffers and luminous ceilings find increasing favor.

Control. Panel boards are often located in web of vertical beams, with wiring in duct rather than conduit. Where contactor control is used, panels can be set in trusses with push-button stations at convenient spots.

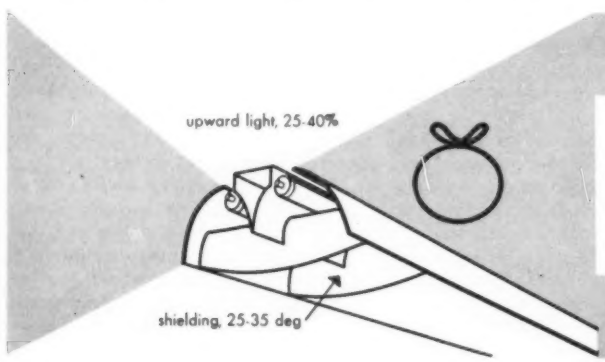
In general, lighting-circuit voltages are limited to 150 v to ground, according to National Electrical Code. But it is OK to go to 300 v in industrial plants, using mogul lamp holders or others specifically approved for higher voltage. Switches can't be installed as part of such fixtures, which must be mounted not less than 8 ft from the floor.

Newer color-improved mercury vapor units, even though being slow in restarting, used as a main light source, with scattered supplementary filament lamps in wide, flat reflectors. An automatically transferred auxiliary feed supplies the filaments if the regular feed to the mercuries goes out. With machines presumably shut down at the same time, the scattered filament lamps give enough light to prevent accidents.

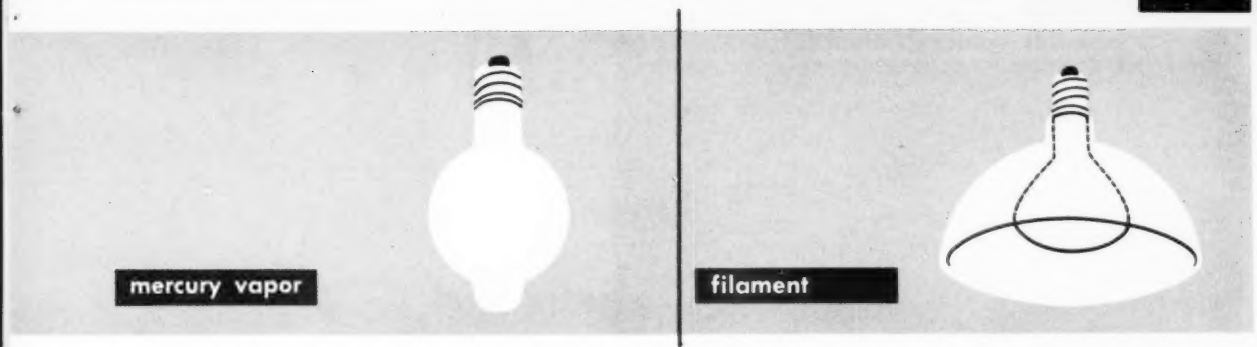
Power Sources. More engineers now give serious thought to supplying lighting load from same feeds as production machines. By contrast, welding is being isolated from lighting.

In the move toward higher voltage, 277 v appears most promising. Lighting fixtures are fed between the 3-phase lines and neutral of 480-v secondary-distribution system. In industrial plants, contactor control is used with 120-v control circuits. Similar technique is used in offices except that 24-v relaying is adopted for switching.

Another scheme taps dry-type transformers into a 440-v



Today's quality lighting can't be had with fixtures having 13-deg shielding, no upward light, dark exterior finish. Sketch shows design now thought most suitable for getting high-level illumination and working-area comfort



Now popular in 3-kw size for high-bay lighting, mercury-vapor lamps offer about 2½ times filament efficiency. Like fluorescents, they need ballasts to get right starting voltage, limit operating current. Life runs 4000 to 6000 hr.

Although mercury-vapor first cost runs roughly 2½ times that of filaments, over-all cost is lowest. Drawbacks have been characteristic blue color and time needed to restart after shutdown — 5 to 10 min. To get around these problems, many plants bank mercury-vapor and filament lamps.

Color-improved mercuries (up to 1000 w) give color about equal to standard mercury units banked with equal wattage of filaments. Color-improved lamps cost more, give 10-20% less light output than standard. Restarting problem isn't licked, so some banking with filaments is still necessary.

This granddaddy of light sources still offers lowest first cost, easiest directional control, lowest over-all maintenance costs. Life expectancy, in order of 1000 hr, depends closely on operating voltage. In addition to standard 120-v lamps, 240-v are available but aren't widely used because of lower efficiency, fragile filaments, higher first cost.

Keep filament lamps in mind where power costs are exceptionally low, for spot and protective lighting, for auxiliaries with high-bay mercuries, possibly on an emergency power-supply circuit. Filament lamps are well suited for hazardous areas, for outdoor and warehouse locations.

Built-in-reflector filament lamps, now with 2000-hr rating, cut maintenance costs. But trend is to use shield anyway, to protect against drips that might shatter lamp.

...shifts to better and more economical ways of supplying light

secondary-distribution system for a secondary voltage of 120/240 or 120/208, 3 phase, 4 wire. Big advantage is a readily available 120-v source for small tools, etc.

Some plants tie mercury-vapor lamps directly into these 440-v systems, especially high-wattage units.

Opponents of higher lighting voltages argue on safety grounds, and point to the need for supplementary equipment to supply usual small 120-v demands.

Group Replacement. Growing cost of maintenance and downtime leads more and more plants to adopt group replacement. A complete section or floor is relamped at one time. Best 20% of lamps removed are saved; these form spares for replacing lamps that burn out before next group replacement.

What is best replacement interval? Many studies point to replacing when spares from last relamping are all used. Keep in mind the importance of setting up a fixture cleaning program to work hand in hand with the replacement scheme.

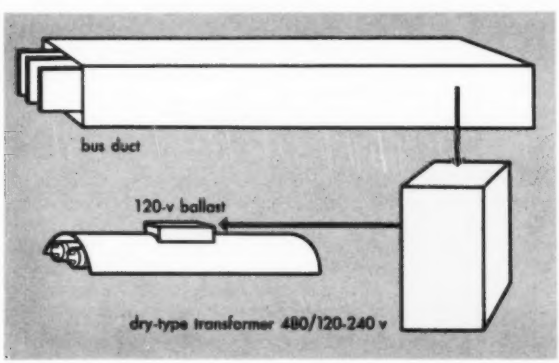
High-Frequency Lighting. Still in development stage, this radically new method uses slimline fluorescents at 360 cycles. Operating at higher currents than practical at 60 cycles, lamps are reported to have 40% more light output. Tiny capacitors weighing a few ounces replace the standard heavier ballasts.

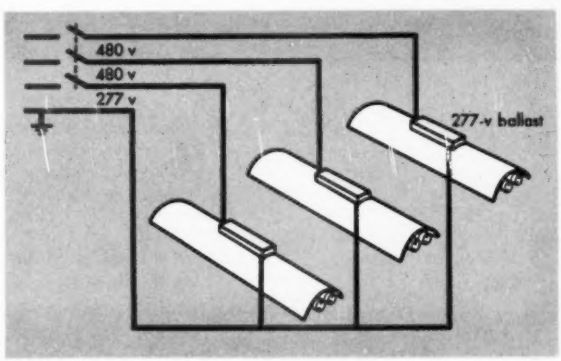
Square current-wave form developed by magnetic frequency converter helps give greater lumen output per lamp. A simple control on converter panel increases or decreases lamp current and lumen output. This may prove a convenient way to make up for deterioration losses during lamp life.

Upshot is a promise of lighter fixtures, less heat load in air-conditioned spaces, silent operation (no 60-cycle hum).

Hazardous Locations. Why are poor lighting installations found in so many hazardous locations? The plant engineer may not recognize some conditions as hazardous, or may not know that proper lighting units are available for such conditions. Local inspection authorities haven't been too well versed in hazardous-location work and equipment. On top of it all is a belief that equipment is too costly.

Bear in mind that hazardous locations aren't confined to powder plants, refineries, etc. Nearly all plants contain some hazardous areas — paint-spray booths, for example. It is important to recognize such areas and use safe equipment in them. Safety is paramount and must get attention even ahead of adequate lighting from a foot-candle point of view.





a look into industry's electrical future

plants——Power engineer's job will grow as mechanization continues in air-conditioned sound conditioned plants. Lighting engineers see fewer windows — "black areas by night and bright spots by day . . . a stumbling block to uniform controlled lighting." Reduced window space will cut initial costs, heating and air-conditioning losses. Narrow seeing strips will give workers psychological comfort.

machines——Shift toward automation will throw spotlight on electrical control with simpler components. Voltages will continue their upward climb, paced by better insulations and mechanical designs. Equipment size will shrink as temperatures rise. Higher frequencies, smaller components (example: transistors), better insulations will also contribute.

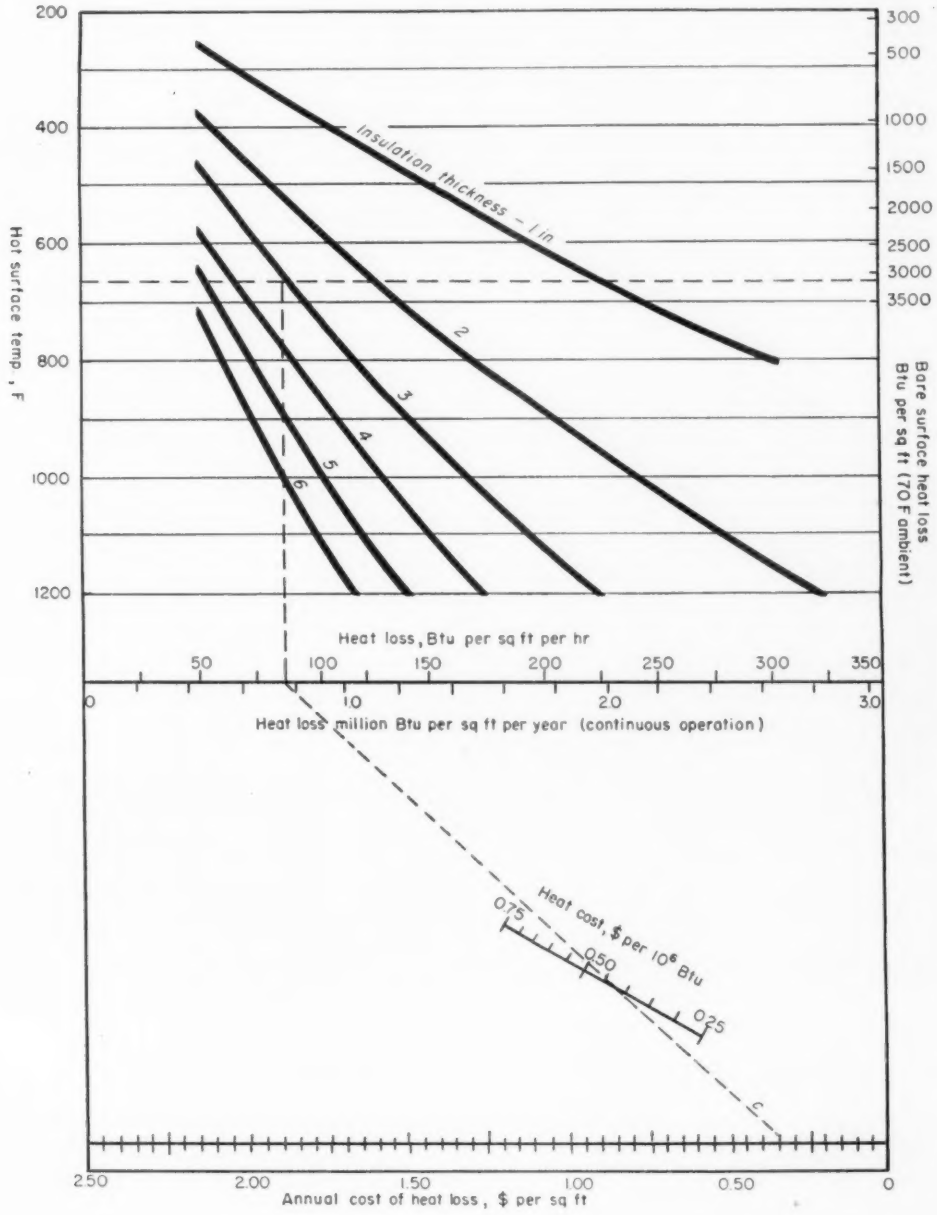
March of packaged equipment will go on — in spite of some who feel optimum has been reached. More dollar savings will come from cutting field labor.

Plastic electrical conduit will make its debut, promising no bending and threading, plus light weight. Aluminum installations will grow as engineers learn to design and install the light metal as a system, rather than spottily as a copper substitute.

Motor designers will pinpoint frame sizes for a smaller hp range rather than extend multi-frame practice. With wider adoption of 277 v, power engineers are wondering about pressing for 277-v single-phase motors for small applications — water coolers, fans.

operation——Electrical maintenance men will need better savvy. Smart power engineers will seek out technical men rather than "conduit benders." In-plant training courses for electricians will grow. Keen manufacturers will aid with better manuals and streamlined drawings for quick trouble-shooting.

a special report — October 1953 — Power



Cost of Heat Loss—Insulated Vessels

► THIS HEAT-LOSS GRAPH helps determine economic thickness of mineral-wool blanket insulation by giving the approximate *annual cost of heat loss* (dollars per sq ft) for selected *insulation thicknesses* (in.) at specified *hot-surface temperatures* (deg F) and at specific *fuel costs per million Btu* (dollars).

Example: To compare heat-loss cost for 1-, 2½- and 3-in. thicknesses of mineral-wool blanket insulation on a steam-heated tank operating continuously at 660 F, the three values of heat loss per year (million Btu per sq ft) are first found (dotted lines) on vertical center scale. With an assumed fuel cost per million Btu of $0.40, annual heat-loss costs per sq ft are $0.80 (1 in.), $0.38 (2½ in.), and $0.33 (3 in.). Selection of either 2½ or 3 in. (1 in. is clearly too little here) is governed by relative installation cost (materials and labor) of the two thicknesses and the anticipated useful life of the tank.

Industrial Mineral Fiber Institute, Inc, New York, N. Y.

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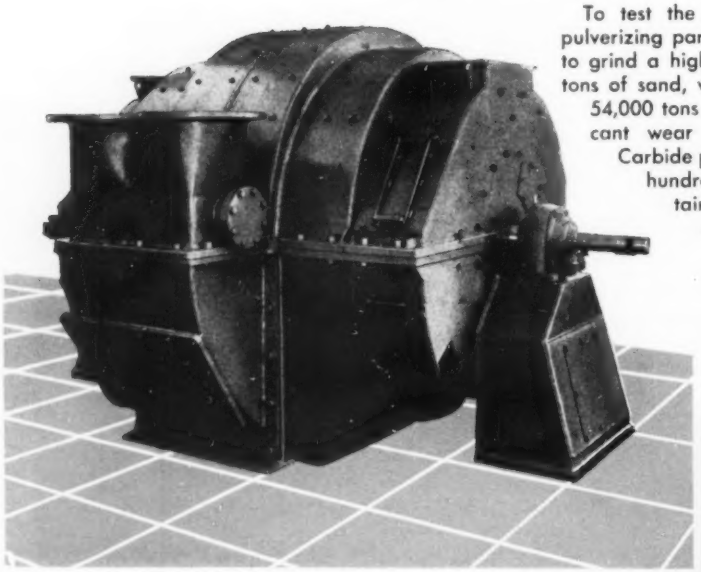
One Reason for Long Operating Performance and Low Maintenance of

RILEY "50" Pulverizers...

Tungsten Carbide facing on pulverizing parts of Riley "50" Pulverizers has demonstrated phenomenal resistance to abrasion in coal grinding service . . . And no wonder! Tungsten Carbide is the hardest of manufactured materials . . . approaching the hardness of the diamond! It is so tough and wear resistant that it is used in bits for stone drilling and mining. Naturally, then, Tungsten Carbide is the best material for use in coal pulverization.

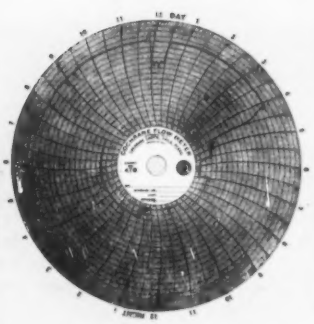


The Riley "50" Duplex Pulverizer

To test the performance of Tungsten Carbide faced pulverizing parts, Riley Engineers set up a Riley Pulverizer to grind a highly abrasive silica sand. After grinding 180 tons of sand, which is the equivalent in abrasive wear to 54,000 tons of coal of an average quality, the insignificant wear which occurred indicated that Tungsten Carbide parts in Riley "50" Pulverizers could pulverize hundreds of thousands of tons of coal with sustained high fineness before requiring replacement. Maintenance records of Riley "50" Pulverizer installations have proved the effectiveness of tungsten carbide in providing long continuous periods of operation with low maintenance costs per ton and sustained fineness.

Here are other ways by which you'll profit from Riley "50" Pulverizers

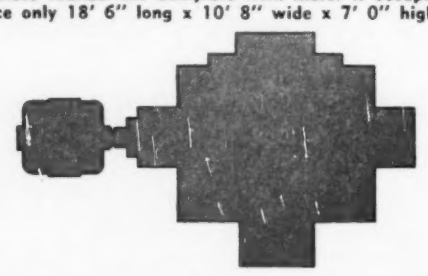
Save Fuel!



Sustained high degree of fineness and complete combustion with Riley burners maintain low carbon losses. Also many Engineers find it hard to believe the wide load ranges and stable ignition possible with Riley Pulverizers. Many Riley installations operate with load ranges of 10 to 1 with perfectly stable operation.

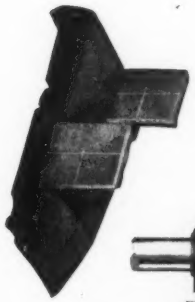
Save Space!

A typical 40,000 lbs/hr. Riley "50" model weighs only 46,000 lbs. and requires a mere 27" deep reinforced concrete foundation. Complete with motor it occupies a space only 18' 6" long x 10' 8" wide x 7' 0" high.

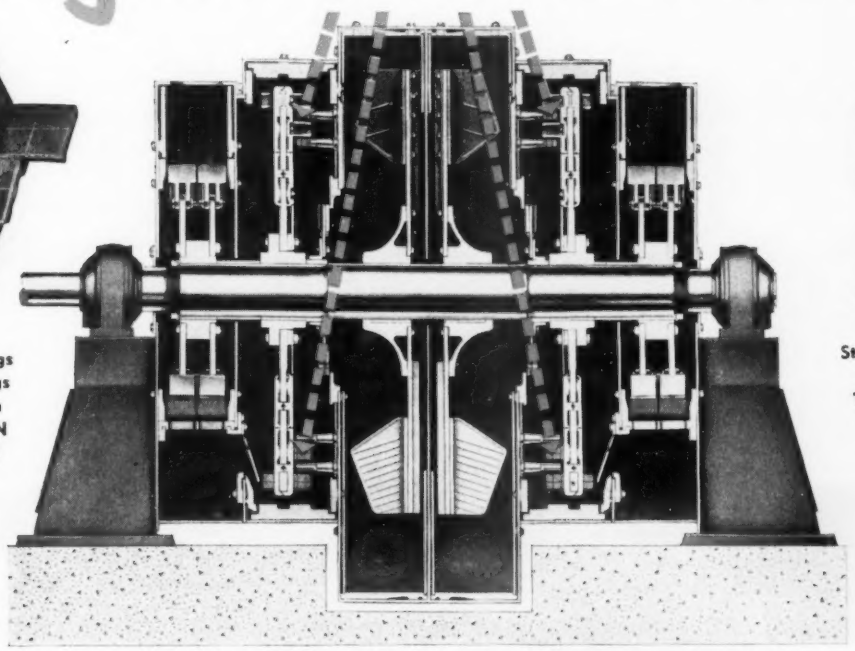


Be sure to ask your Riley Representative to point out the

tungsten carbide!



Moving Pegs are forgings faced with **TUNGSTEN CARBIDE**



Stationary Peg faced with **TUNGSTEN CARBIDE**

RILEY
STOKER CORPORATION

WORCESTER, MASS:

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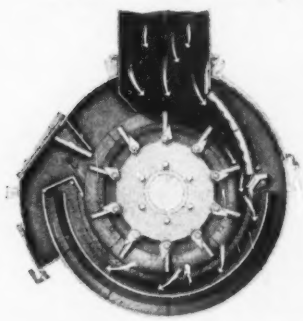
WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

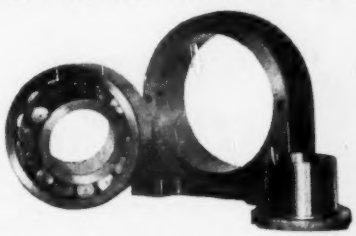
Save On Capital Investment!



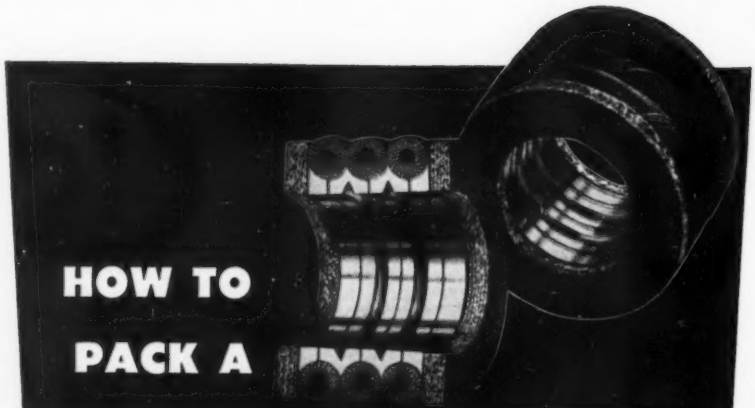
There is no need to install an oversized mill to take care of coals of high moisture. New Crusher Dryer section is designed with ample capacity for coals of highest moisture content. Surface moisture of coal is evaporated in this section before entering main pulverizer. There is no capacity reduction with increase in moisture. In addition, foreign materials and tramp iron are rejected, thereby, reducing maintenance and preventing damage to pulverizing parts.

Quiet Operation!

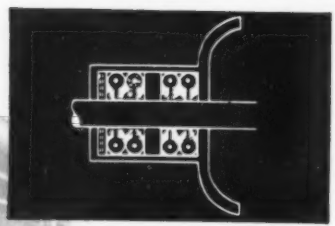
Heavy duty railway type bearings and absence of metal to metal contact insures quiet, vibrationless operation. Even when coal feed is shut off the "50" Pulverizer operates quietly, without wear of parts.



many operating advantages of the new Riley "50" Pulverizer.

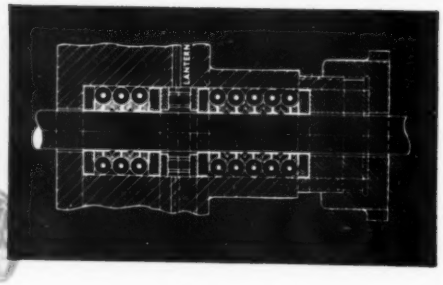


HOW TO PACK A REFRIGERATION COMPRESSOR "FOR KEEPS"



Chesterton 444 is full metallic on rod or shaft. It runs frictionless without usual gland pressure. Why? It's due to E-L-A-S-T-I-C back and *built-in oil seal* in each Metallic ring. These special metal rings are soft enough to machine themselves to rod imperfections. 8 to 10 years uninterrupted service is common with Chesterton 444.

Chesterton 444, formerly Austin-Mason, is the most famous name in refrigeration packing. Easy to install — each ring is cut so it may be opened to fit over rod or shaft. Full directions accompany every set. Unexcelled for Ammonia, Freon, CO_2, steam, brine, air and other liquids and gases.



Chesterton 444

PACKING Chesterton SERVICE

PACKING PROBLEMS by J. W. Hartley

Gaskets That Won't Bond to Flange

When you want to make a tight joint that will still open cleanly, use Chesterton Russo #210 Sheet Packing. Complete graphite impregnation of long asbestos fibers does the job. Cuts smoothly . . . Jack Hartley is one of the real old-timers of the packing business. Write him your problems.

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Turner Sup., Mobile
Wimberly & Thomas Birm.

Arizona
Geo. S. Thomson, Phoenix

Arkansas
A. S. Kelly, West Helena
McKee-Pitts, Fort Smith

California
Mission Pipe & Sup, San Diego
Victor Belt. & Rub., L.A.
Holx Tire & Rub., Lodi
Valley Pipe & Sup., Fresno
Western Ind. Sup., Sacr.

Colorado
T. R. Stevens, Denver

Connecticut
Lindquist Hdw., Brdpt.
Jackson & Sequine, Hart.
C. N. Flagg, Meriden
Abel Trans., Plainville

Florida
Farquhar Mch., Jacks.
Mine & Mill Sup., Lakeland
Railey-Milam, Miami

Georgia
Pye-Barker, Atlanta
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Illinois
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Indiana
W. J. Holliday, Indpolis
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Baker Spec. & Sup., Logansport
M&M Sup Co., Muncie

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Kansas
Crane Co., Topeka

Kentucky
Louisville Mill Co., Louisville
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Louisiana
Paul, Rice & Levy, New Orleans
Service to Sawmilliers, Shreveport

Maine
Hall & Knight, Lewiston

Massachusetts
Fall River Steam & Gas Pipe, Fall River
Holyoke Valve & Hydrant, Holy.
Industrial Sup., Worc.
Robbins-Gamwell, Pitts.
Zina Goodell, Salem
Albert E Mayer, Sprng.

Michigan
Northern Hdw., Menominee
Kenneth Anderson, Detr.
Mfrs. Eq. & Sup., Flint

Minnesota
Goodin Co., Minapolis
Duluth Plumbing, Duluth

Mississippi
John S. Stilley, Jackson

Missouri
Kansas City Rub. & Belt., K.C.
Rubber Prod. Co., St. Louis
Jamieson Mch., St. Jo.

Nebraska
Interstate Mch. & Sup., Omaha

Nevada
Sierra Mch., Reno

New Jersey
Fleck Co., Camden
Mfg. Selling, Trenton

New York
Kasper & Koetzle, Brklyn.
Root, Neal, Buffalo
Burns Piping, Syracuse
Beltran Assoc., N.Y.C.
Colerick Sup., Utica
Geo. H Cole, Troy

North Carolina
Bernhardt-Seagle, Lenoir
Gen. Fdy & Mch., Sanford
Sykes Sup. Co., Burl.
A. Lynn Thomas, Charlotte & Raleigh
Cape Fear Sup., Fayetteville
Citizens Tran. & Coal, Asheville

Ohio
Clark Asbestos Co., Cleveland
Shaw-Kendall Eng., Toledo
Yohe Sup., Canton
Monarch Petr. Prod., Columbus
Focke Rub. Pro., Dayton

Oklahoma
Hart Ind. Sup., Okl City

Oregon
Ken McDowell Co., Portland

Pennsylvania
Perry Mill, Erie
Raub Sup. Co., Harrisburg & Lancaster
E. Keeler Co., Willsport
Bush-Miller, York
Somers, Fitler & Todd, Pitts.
Harris Hdw., Kingston
Lehigh Val. Sup., Allentown

S. Carolina
Sullivan Hdw., Anderson
Allen & Webb, Charlstn.
A. Lynn Thomas, Columbia

Tennessee
Nashville Mch. & Sup., Nashville
Browning Belt. & Sup., Knoxville
Pidgeon-Thomas Iron, Memphis
Rogers-Bailey Sup., Chattanooga
Summers Hdw. & Sup., Johnson City

Texas
Zork Hdw., El Paso
Hornsby Heavy Hdw, Wichita Falls
Conroe Mill Sup., Conroe

Utah
Schieren-Jarvis, Salt Lake

Virginia
Barker-Jennings, Lynchburg
A. Lynn Thomas., Richmond & Norfolk

Washington
Titan Chain Saw, Seattle
Jensen-Byrd, Spokane
Paramnt. Sup., Tacoma

Wisconsin
Shadbolt & Boyd, Milw.
Pumps & Equip., Madison

Canada
Gordon-Belyea, Vancouver
Crown Mech. Pkgs., Montreal
John Clouston, St. John's, Nfld.

Hawaiian Islands
P. S. Pell & Co. Ltd.— Honolulu

Alaska
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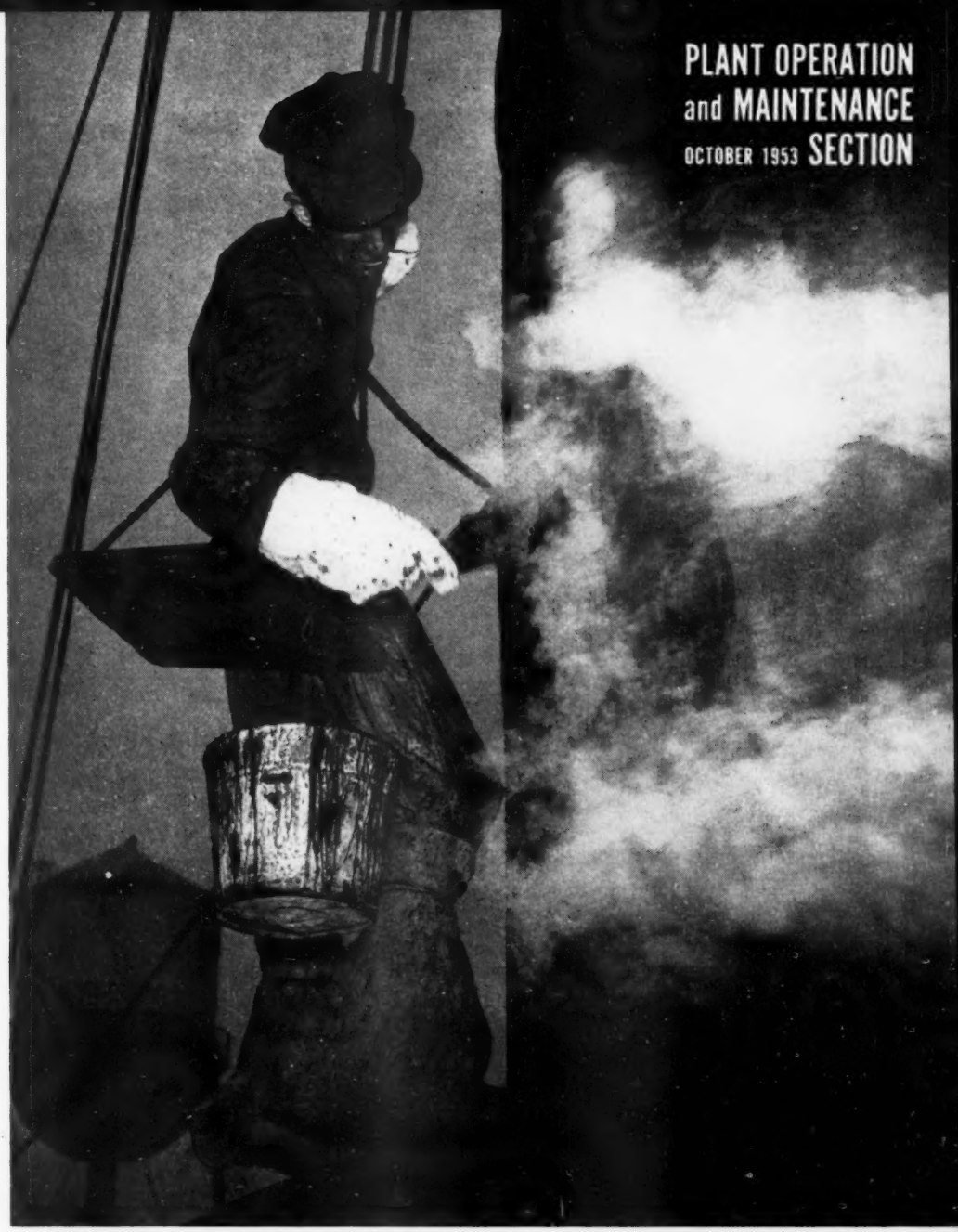
AMERICA'S OLDEST MANUFACTURER OF MECHANICAL PACKINGS

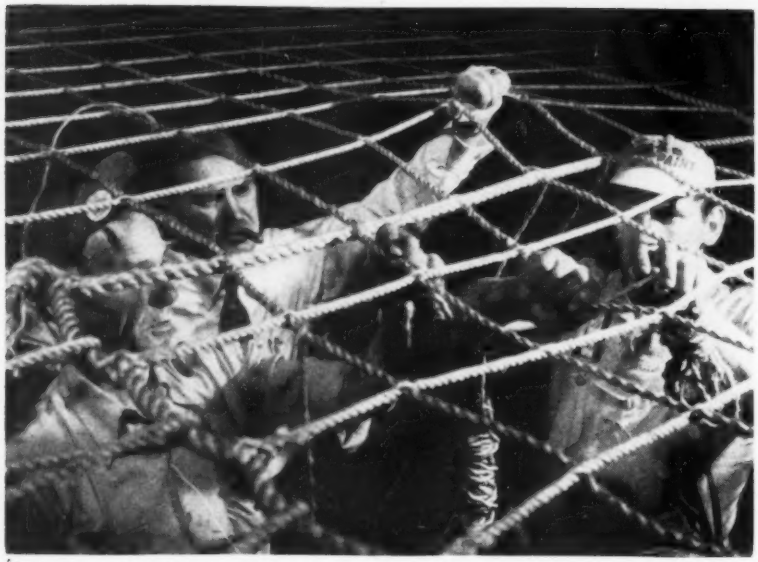


LONG LIFE assured for this hot stack because heat-resistant paint is applied to hot surface

Cover That Surface but...

. . . make sure that surface is clean • you have the right primer • mill scale is rusted off new metal • your color scheme is right • you do the job safely • running machinery is protected • in particular, see that you get what you pay for **By Steve Elonka, Associate Editor**

TURN PAGE ►



NET, woven to protect steam turbines, is inspected by Art Cannon. Ropes are strong enough to support workmen, materials. This is also good insurance against outage

SAFETY NET with dropcloth is spread above machinery before painters work on 70-ft-high ceiling in power plant. Paint splashes and dropped tools kept from machinery

Soak Up This...

► "SAVE THE SURFACE and you save all" is good advice, but just *how* do you save the surface? For an answer to this and other plant-painting questions, I visited Art Cannon of Oliver B Cannon & Sons, in Philadelphia. With 32 painting crews about the country, Art Cannon is our leading industrial painting contractor.

Regardless of who does your painting, you should know how this topnotch industrial specialist goes about a job. Then you will see that painting takes plenty of know-how.

Staff Meetings. Art Cannon has staff meetings each month. His key men fly in from the field. Sales, estimating, production and testing personnel attend. An expert from a paint manufacturer, one from a chemical firm, or a specialist on corrosion, etc. is usually present.

Current jobs are discussed and solutions arrived at. Art's own paint chemist gives lab findings on new products. He also advises on tough surface-protection problems and licking some unusual local condition.

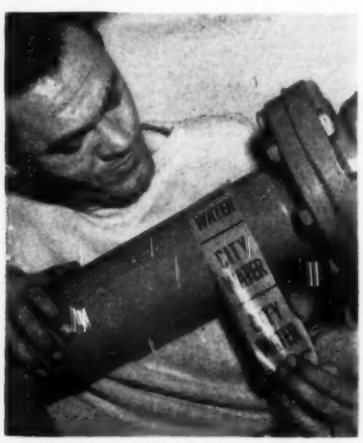
Everyone has a chance to put in his oar. So supervisors go back into the field ready to tackle their problems from a new slant. Do these meetings pay off? They helped put this firm at the head of the list, competing with local contractors everywhere.

Another reason Cannon does so much work in power plants is that his experts do critical areas, without a shutdown. The plant's regular painting crew does routine safe areas that almost any painter can do.

Every Cannon supervisor has ten years

SAFETY SIGNS tell plant employes that men are working above them here

PROTECT running machinery with dropcloth over frames so no shutdown's needed



IDENTIFY pipes with removable plastic strips, either lettered or plain colors

...Information Before Painting Your Plant

of previous training with the firm. Safety is a big item, especially when working high above and around machinery, as in power plants. A green painter always works with a trained man until he knows the ropes.

Estimating is important. Condition of each building or section is listed as good, fair, poor or very poor. When to paint, next scheduled repainting, quotation and comments are listed. Here are some typical remarks I copied from an $85,000 estimate:

"(1) Buildings can wait until rehabilitation program is scheduled, then interior and exterior painting can be done. (2) Buildings viewed by public need painting for public relations and appearance. (3) Can wait until more essential buildings are finished. (4) Building important to production should be done before more replacements are needed."

Scheduling. All preparations are completed *before* plant is shut down. That means putting up protection, having enough men for shutdown equipment so work isn't held up, etc.

His average power-plant team of painters is about 40 men. Idea is to put as many men as possible on a job at one time as overhead costs the same for 10 men as for 100.

Safety. Each painting super checks scaffolds, ladders, rope and other equipment before sending them to a job. Safety nets are homemade because Art isn't satisfied with ones on market. Every rope, scaffold, ladder, etc, is numbered and recorded on an office card. Age, repairs and all other data are jotted down. All rope is scrapped after one year's service, regardless of condition. "CAUTION, men working overhead" signs are placed below painters. Because of an excellent safety record, this firm has very low insurance rates.

Doing the Job. Here are a few rules on painting: Wire-brush, scrape or chip all rust and corrosion spots. Vacuum-clean to prevent loose dust, flyash, etc, getting into machinery.

Spraying can be more expensive than a brush job as it needs more protection. But, usually, spraying gives a thinner coat, does not protect as well.

Never red-lead new metal exposed to weather. When building outdoor metal tanks and steel structure, let them rust for a year or two until all mill-scale rusts off. Coat of primer and paint lasts on such a job. If red lead is painted over new metal, mill scale peels off with time, taking new paint with it.

In our electric-generating plants, 35% burn coal, 35% burn oil or gas, 30% are hydroelectric. Newest plants can switch from coal to oil, whichever is cheaper. These dual-design boilers present temperature problems.

Ducts get hotter when oil-fired, need a heat-resistant paint to cover changing temperatures. Aluminum is often used —one coat. Aluminum's varnish-vehicle stacks up with other enamels. If not aluminum, use a light pearl gray, a semi-alkyd oil-base paint, with a semi-gloss finish. There is no good heat-resistant paint in green or blue. Here are a few color schemes for power plants.

Turbine Room, ceiling—oyster white for right light reflection. Ceilings are usually 60 to 70 feet high. Light green or cream adds good character to this room. Walls—light gray. Machinery —soft green enamel.

Boiler room, ceiling—oyster white. If walls are brick, well struck and pointed, or of good monolithic concrete, leave unpainted. Don't paint unnecessarily if surface is attractive and needs no protection. Once painted, a surface must always be painted. Use heat-resistant aluminum or a gray paint for boilers and adjacent piping, boiler doors, buck stays and ducts.

Piping. Paint the same color as boiler. Paint all insulated piping connected with boiler feed system a contrasting enamel of dark gray or green. On other machinery, such as pumps, drivers, coal pulverizers, coal feeders, use a gray hard-drying gloss surface. Colored plastic bands are best for piping. If over 12 colors are used, have labeled bands. Adopt U.S. Bureau of Ships color scheme.

Crane. Paint high-visibility yellow for safety.

Railing. Paint top rail black, so soiling from hands won't show. Paint middle rail safety yellow, and the rest gray. Yellow middle-rail makes stairway "stand out" for quick access to trouble spot.

Fire Lines. Paint red or use red bands to identify them.

Stacks. Paint with special coating to withstand temperature. Paint aluminum stacks at top with broad black band to camouflage smoke discoloration.

"Remember," Art Cannon reminded me as I left, "It costs more not to paint."

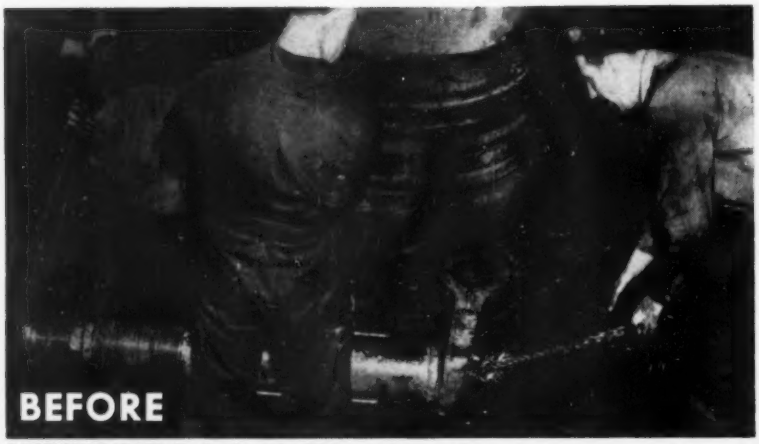
CORROSION is tough on steel sash if putty fails between glass and the sash

CALK steel sash with gun after digging out old putty—before painting sash

SPRAYING: not usually as good as brush work, calls for mask in close quarters

OPERATORS' NOTEBOOK 68

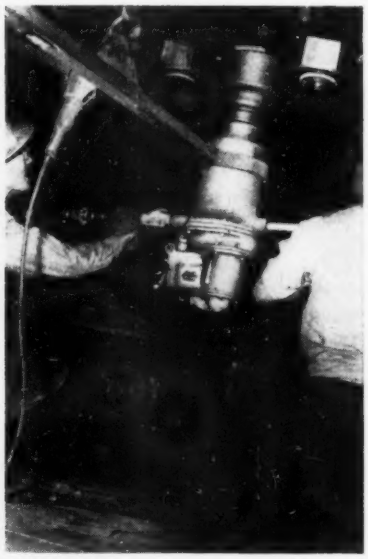
Stop Wasting Man-Hours



BATTERING RAM *(before)* took 294 man-hours of sweat to remove, replace nuts on fifty-four 5-in. bolts of 115,000-hp hydro-generator's drive-shaft couplings

IMPACT WRENCH *(after)* takes 7½ man-hours of easy work. Wrench saved $12,300 in outage alone, paying for itself 8½ times on this very first heavy repair

SAVED $12,913

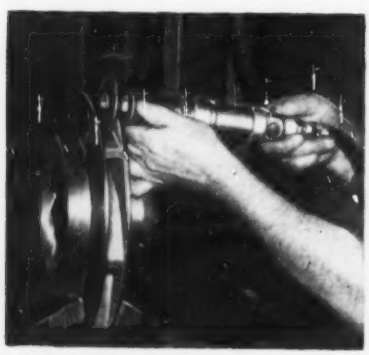


TIGHTENING nuts under runner. Cable through shaft hole supports impact tool

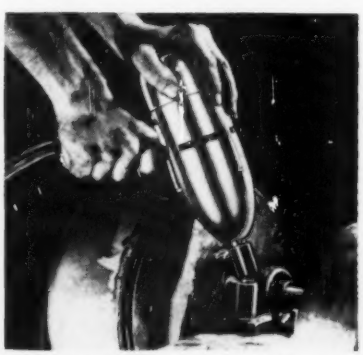
Power tools are slashing maintenance bills in many modern plants today. To rebuild a 115,000-hp hydro-generator, for example, fifty-four 5-in. diameter bolts were removed, replaced and tightened. Bolts hold three couplings together on drive shaft shown, between water wheel and generator.

Before, it took six men 21 hours.

OTHER USES



VANES on pump impeller are ground fast instead of being slowly filed by hand



ODD PLACES are reached with power tools by using the universal attachments

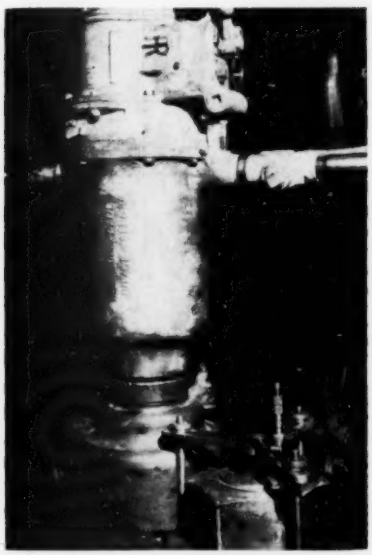
REAMING holes to line up machinery is a cinch with this 90-degree power tool

And Use Power Tools

By STEVE ELONKA, *Associate Editor*

LOWERING heavy hub bolts into place before tightening and stretching them

SNUGGING UP nuts on bolts manually before stretching with the impact tool



TRIPOD and micrometer depth-gage is used to measure the stretch of each bolt

using a 450-lb battering ram to remove the nuts. Then it took seven men another 24 hours with the same ram to tighten the nuts. That's a total of 294 man-hours.

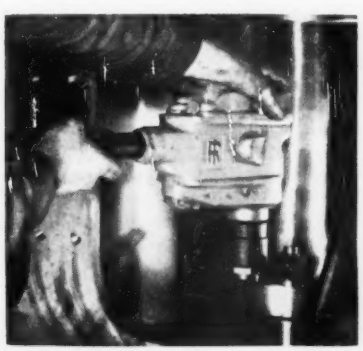
With impact wrench shown, two men removed the 54 nuts in 1¾ hours. Then two men tightened them in two hours. That's a total of 7½ man-hours, saving 286.4 man-hours for the complete job.

At $2.15 per hour, $612.98 was saved in labor alone. Besides, total of 41 hours' down-time was saved. As hydro-generator earns about $300 an hour when operating, saving is $300 × 41, or $12,300. That brings total saving to about $12,913 on this one maintenance job alone. This first job paid for large impact wrench 8.6 times in first 3¾ hours' use, which is good investment.

Nuts were tightened until the 5-in. diameter × 21-in. bolts showed at least 0.012-in. stretch on stretch gage.

Power tools are made for many uses. Once you get in the habit of letting these tools sweat for you, you'll use them wherever possible, and save money.

GEAR PULLER removes sprocket wheel from electric motor by pressing a button



DIESEL crank-nuts must be tight. This impact tool gets into some close places

CONE WHEEL finishes inlet of pump impeller that is awkward for hand file

NOW! No More Flyash

After spending money for years in trying to stop flyash in a residential neighborhood, plant manager installs air jets, so staggered that they swirl the sawdust in the furnace

CEDAR FUEL is examined by plant superintendent H Kendall as it's drawn into the duct. It was the coarser particles that came out of stack unburned, gave trouble

► "STOP YOUR SOOT from spoiling my wash," yelled an excited voice into the phone. "Stop it this minute or I'll sue you—I've stood about enough." Then the receiver banged down before the firm's telephone operator could say a word. So she called Henry C Kendall, plant superintendent, as she had done so many, many, *many* times.

Kendall is the youthful, good-natured superintendent of George C Brown & Co, Greensboro, N. C. This firm is the world's largest manufacturer of aromatic red-cedar products. Their four major products are: closet lining, veneer for cedar chests, cedar oil and dog bedding.

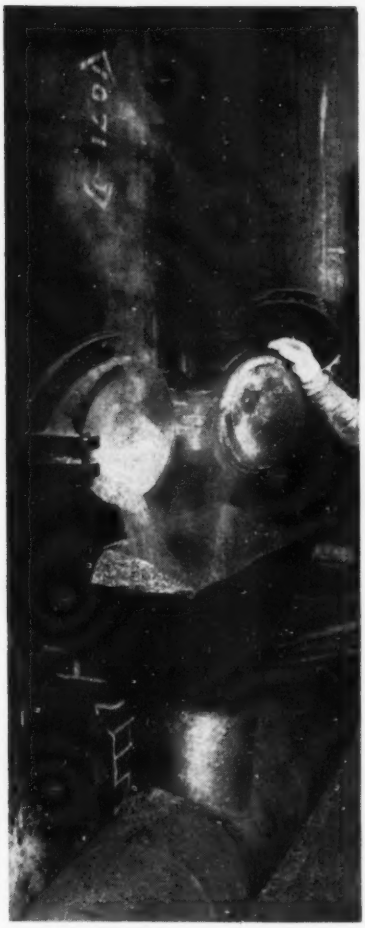
Flyash Trouble. Like most plant superintendents, Henry Kendall was up to his ears in work that morning. Telephone calls from irate neighbors were commonplace, because the plant is in a semi-residential neighborhood. What irked Mr. Kendall about these calls was that he had been experimenting and spending a lot of money, for years, in trying to stop that flyash. But this time the firm was about to be sued, and something drastic *had* to be done.

Main Boiler for this plant is a 350-hp longitudinal-drum straight-tube design, carrying 155 psi, operating at 10,000 lb of steam per hour. It burns about 25 tons of sawdust and ground shavings in 24 hours, or about one ton per hour.

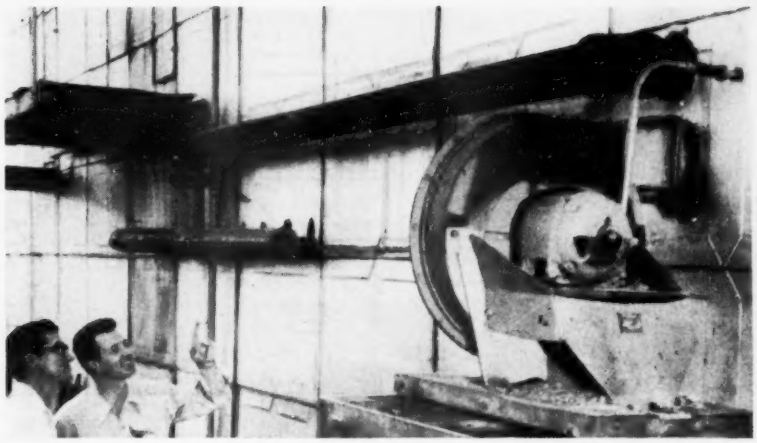
Boiler, installed in 1927, operates on natural draft through three ashpit doors. Sawdust is burned in the large dutch-oven built onto the furnace front. Air passes through the grates to dutch oven.

The wood fuel drops in through two ports in oven's roof, sketch, p 135. Fuel piles into form of huge cone on top of grates and burns rapidly. This fuel comes from cutoff saws, rip saws, and band resaws. Fuel is composed of shavings, sawmill dust and waste that's hogged up. Screens on fuel hog that chops up fuel have ¼-inch openings. It was these larger hogged pieces that came out of the stack as charcoal and spread over the neighborhood. Trouble was there wasn't enough air to burn pieces inside the furnace completely while they were suspended.

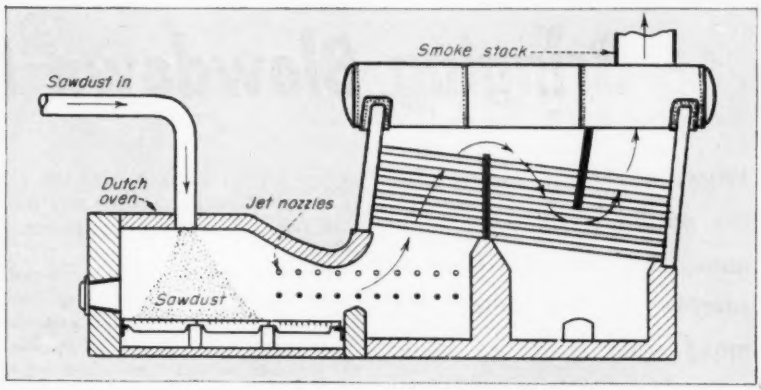
Process Steam. Steam from boiler has four main uses. Its chief use is distilling oil from the cedar sawdust before the fuel is burned. Waste is ground and then put in vats where it is saturated with steam. Steam carries oil through condensers where the oil and water separate. Left photo, p 135, shows one of 19 vats. Each is 5 ft in diameter and 12 ft high. Each uses 325 lb of steam per hour, which adds up.



PROCESSED FUEL has 35% moisture after the "oil of cedar" is steamed out



BLOWER shoves air into large U-shaped header at front of boiler for jets on boiler sides. Kendall and assistant Puckett are happy because problem is solved



JET NOZZLES feed excess air in left side of oven and furnace, 30 in. above nozzles on right side (black dots). That makes sawdust swirl and burn before leaving furnace

Steam enters the vat's double bottom at 3 psi and blows up through 2000 1/16-in. size holes, into sawdust. After about 14 hours, 60 lb of expensive "oil of cedarwood" are distilled. The sawdust fuel, containing about 35% moisture is then dumped. From there, fuel goes to the dutch oven to be burned.

There is more fuel than the mill needs, so efficient firing is no problem. But there must be no smoke or flyash to pollute the air. And that does call for careful firing.

Kilns for drying the rough-sawed cedar boards use steam at 145 psi. There are two double-track kilns. Finned pipe and pipe coils keep them at 150 F. Humidity and temperature in each kiln are automatically controlled.

Another use for steam is building heating. Steam is also used for the veneer dryers in this busy plant.

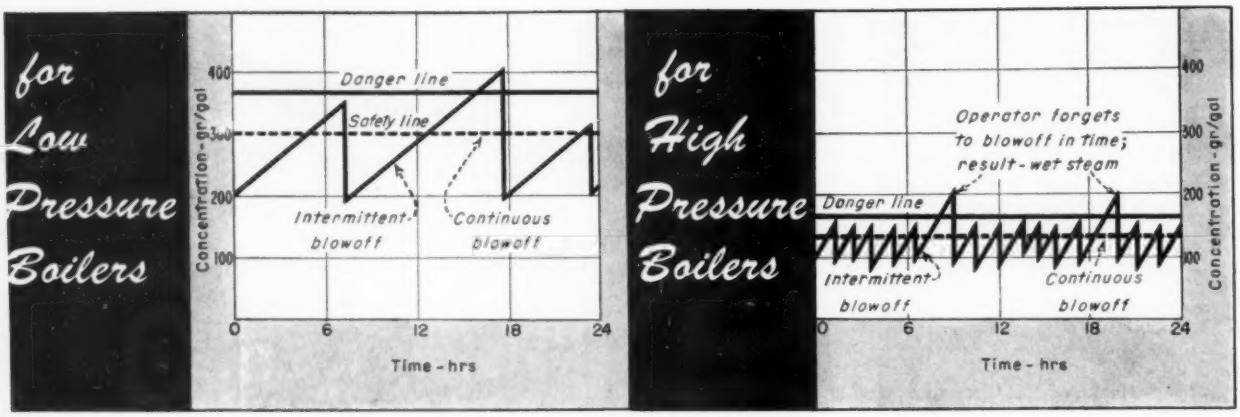
No More Flyash. Once Henry Kendall got on the right track, his flyash problem was quickly solved. He installed an overfire air system, see the photo at right above.

An air blower is mounted outside the boiler room. It's connected with a U-shaped, 6-inch line, reaching from the boiler front around its side. Air from the blower enters this header at the boiler's front. Ten 1½-in. lines carry the air from each side into the dutch oven and into the first pass of the furnace.

The ten jets of air shoot into the furnace, 30 inches lower on one side than the other. This gives a swirling action to the air so it agitates the unburned wood particles in suspension. That helps them burn completely before leaving the furnace. Since jets were installed, some flyash has been noticed at times, but not one complaint has come from fussy neighbors.

Results. Henry Kendall is right pleased with this setup. But he is too busy with production to be kept in the boiler room. Henry started out in general cabinet work, then built truck bodies. Next, he joined a millwork shop and ended up as a pattern maker. Before coming with George C Brown & Co he owned a half interest in a cabinet shop. So you can see he came up the hard way and doesn't let a tough problem stop him.

Now he has a bright, young college graduate, Ferrill Puckett, as an assistant. With the flyash problem licked, both men are concentrating on increasing production. They're also working out a preventive maintenance program that will keep their mill out there in front, as the leader in their field.



Here are the two basic choices you can make in...

Bringing Blowdown Under Control

Water treatment can change the nature of all your boiler scale, but you still have to remove all the solids that make scale from the boiler cycle. Here is how and why

► THE JOB of blowdown seems straightforward enough. It's meant to control the build-up of too many solids in the boiler drum. Left to themselves, these solids bring on serious scaling problems and add still more to operating problems by laying the groundwork for possible foaming, priming, carryover.

The way these solids build up or concentrate shows up readily with calcium sulfate, a moderately soluble salt. You'll find it a fairly common member of most boiler makeup waters. Suppose we consider a feedwater, holding 32 ppm of this calcium sulfate and slated for a boiler operating at 300 psi. The corresponding saturation temperature, 422 F, is a point where calcium sulfate's solubility is 640 ppm, 20 times what we start out with in our feedwater sample. This means we can expose our feedwater to 20 cycles of evaporation or concentration. Or stated another way, we can evaporate 20 gallons of feedwater down to not less than one gallon without going beyond the calcium sulfate solubility. But any more than this, and the excess drops out of solution.

Blowdown Needs. To keep on making steam we have to bring in fresh water as replacement. This incoming water brings with it 32 ppm of dissolved calcium sulfate that drops right out of solution and creates a scaling problem. If, however, we pull out one gallon of boiler water, we can add 20 gallons of fresh water before we're up against this same problem. In our case this would mean only 1/20th of the boiler feed, or 5%—a fairly reasonable blowdown rate.

But the exact amount of blowdown isn't determined by calcium sulfate alone. Instead, what decides the safe blowdown rate is all the individual compounds the feedwater brings to the boiler drum, the water-treatment chemicals you add, plus their effect on one another to form possibly still different compounds of different solubility limits, plus the boiler operating pressure and temperature and their effect on solubility. When you come to pick blowdown rate for your boiler you'd better call in a reliable water-treatment consultant. He'll set you straight. Table, left on p 137, is only a rough guide.

Over and above this problem of holding total dissolved solids in the boiler water within safe solubility limits is the one of keeping a curb on suspended solids—that is, those that are no longer bound in solution but are free to drop out. We have it on pretty good authority that most of these suspended solids do not settle to the lowest point in the boiler as you might guess. Some small percentage do, and you have to put in special takeoffs at these low points to pull them out during blowdown.

But most of these suspended solids are held just below the water surface in the boiler drum by the buoyant force of boiling and rising steam bubbles. Concentration can get so high at this point that the water becomes soupy, its surface tension considerably increased. Then normal steam release is retarded and foaming or priming can develop. So much for the need for blowdown. How is it done?

Blowdown Methods. There are two primary methods of boiler blowdown—intermittent and continuous. The intermittent or manual system is the granddaddy of blowdown methods. And it is still doing a job on the smaller boilers. The takeoff pipes are usually in the low point, or mud drum, and when you blow down, sludge as well as dissolved and suspended solids go out. But because the takeoff pipes do not connect up to the point of highest solids concentration, the blowdown amount runs higher than absolutely necessary to bring the water down to the allowable solubility limits.

In addition, three major disadvan-

Developed from material appearing in the No. 3, 1953 issue of the Armstrong Trap Magazine, Armstrong Machine Works, Three Rivers, Mich.

tages are charged against the intermittent blowdown method. They are: (1) inability to maintain uniform solids concentration, sketches, p 136 (2) the human error—operator's failure to remember to blow down (3) difficulty in setting up any heat recovery.

Continuous blowdown, the second and latest method of removing concentrated solids, answers these major disadvantages. But its value begins to tell only in boilers of better than 4000- to 5000-lb-per-hr steaming capacity, operating at 100 psi and above. As the name suggests, total solids leave the boiler continuously through a pipe that is below the water surface at the point of highest concentration.

Over and above the continuous pipe connection, a takeoff pipe goes in at the boiler low points. Then an occasional manual blowdown in the conventional manner removes any sludge accumulation in the mud drum.

Continuous blowdown gives these strong advantages: uniform solids concentration, entirely automatic operation (except for relatively minor adjustments if rate of solids concentration changes because of, say, makeup water), easy heat recovery.

Heat Recovery. The steps you take for heat recovery, Fig. 1, 2, may or may not include flash tanks. If you can use flash steam, you pass the blowdown water into a flash tank or tanks first, and take off the steam there. Then the unflashed water is passed through heat exchangers. If you have no use for flash steam all the blowdown water goes through the heat exchangers only.

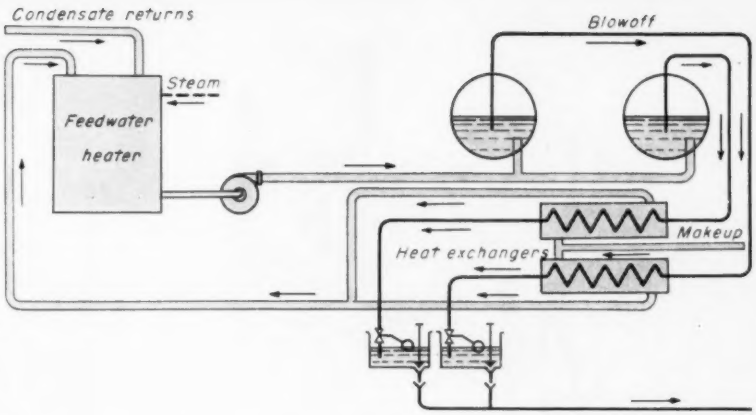
In either arrangement, heat lost is represented by the difference in temperature between the liquid being heated and the blowdown water as each leaves the last heat exchanger.

The costs that intermittent blowdown represents, in table at right, give you some idea of the importance of your blowdown water. For a large boiler, the savings from continuous blowdown pay fairly fast for the heat-recovery equipment and justify its purchase.

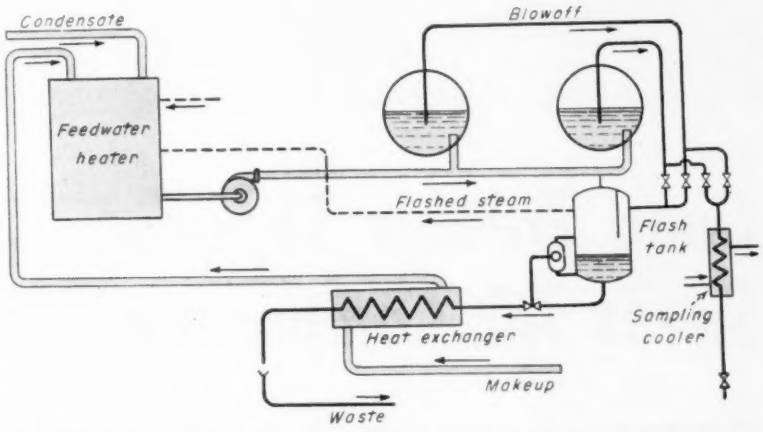
Allowable Boiler Solids

(American Boiler Mfrs Assn)

Pressure at outlet of steam-generating unit, psig	Total solids, ppm
0 — 300	3500
301 — 450	3000
451 — 600	2500
601 — 750	2000
751 — 900	1500
901 — 1000	1250
1001 and higher	1000



1 Heat recovery from boiler-water blowdown for solids controls offers an easy way of getting back all of your cash outlay for the necessary control equipment



2 Flash steam can frequently be used to advantage in a boiler cycle, and with the above hookup continuous blowdown, particularly, proves a good source for it

Average Costs of Blowdown

Press. psig	Temp deg.	1 in.		1½ in.		2 in.		2½ in.		3 in.	
		Lb a min	Lb coal	Lb a min	Lb coal	Lb a min	Lb coal	Lb a min	Lb coal	Lb a min	Lb coal
100	338°	960	33	2400	83	4080	142	5850	203	10500	365
125	353°	1020	37	2640	96	4440	162	6480	237	11100	406
150	366°	1110	42	2880	110	4920	188	7080	271	12000	459
175	377°	1200	47	3120	123	5400	214	7800	309	12900	511
200	388°	1320	54	3360	138	5880	241	8400	344	13800	566
225	397°	1440	61	3600	152	6300	265	9000	379	14700	619
250	406°	1560	66	3840	166	6840	296	9600	415	15600	675
300	421°	1740	78	4200	189	7460	335	10380	467	17280	778
350	435°	1860	87	4560	214	8040	377	11160	523	18960	891
400	448°	2040	99	4920	238	8680	421	11940	579	20700	1004
450	459°	2220	110	5280	263	9240	460	12720	634	22440	1118

INTERMITTENT or manual blowdown lets a certain amount of steam, depending on pressure and valve sizes used, escape. The cost to you shows in the above table

Machine was reversed, idler wedged

A character came to the door

Good Trouble Shooting Saves Air Compressor

When Howard L Livingston of Los Angeles, Calif. took over as the "college boy" compressor operator, many, many years ago, he ran into a fouled machine and a tough character, besides. But common sense put compressor and the character in place

► WHILE WORKING MY WAY through college in 1911-1915, I operated air compressors for a construction firm during my vacations.

One vacation, the boss sent me to a nearby shop to help out. Before I went, I heard stories that this shop's air compressor was no good, that it gave trouble, ran hot, and that the machine was shut down every hour to cool off.

Our master mechanic said I might find the men hard to get on with. Later, I learned that the wives of superintendent and compressor operator were sisters. Also that the women had connections with the firm's head, which was main reason these men held their jobs.

On the Job. As I approached the compressor house that first morning, the silence told me the compressor was shut down. Compressor house was a board-and-batten shack. Next to it was a similar building, which housed the blacksmith shop and a small machine and general-repair shop.

A pile of odds and ends on the scrap pile outside the compressor house attracted my attention. I recognized them as the oiling system and the crankcase and crosshead covers of an air compressor. They were in good condition but very dirty. While I was looking them over, a man came to the door and looked me over suspiciously. He was about 60, had iron-gray hair and wore metal-rimmed glasses. He looked like a tough guy to work with.

The old boy blurted out, "Are you the college boy they sent up to run this plant?" When I said yes, he followed with, "We don't want any of your book learning. On this job, we want men with experience—and a lot of it."

Compressor. By this time I was inside the plant. The compressor was a 2-stage cross-compound machine, belt-driven by a 200-hp squirrel cage motor. I noticed that her crankcase, crosshead covers and oiling system had been removed. Also, a homemade oiling system, requiring constant attention with an oilcan, had been installed. With covers removed, I saw the compressor-house interior was spattered with oil. Compressor was well smeared, too. The motor was far enough away to have missed most of the shower, but it was very dirty.

The driving belt was drawn very tight. Belt's underside near compressor flywheel was running over an idler pulley, supported on a homemade timber cribbing. Timber support had two wedges, evidently driven in by a sledge hammer, to increase belt tension. Motor was far enough from compressor so I couldn't understand why the idler.

Finds Cause. At this point, the old man left me and started oiling the bearings and crosshead guides. He then said they had cooled down enough, so he started the machine. I saw that the compressor was running over, instead of under. This made the top side of the belt the tight side, which explained the idler. It brought the crosshead thrust

"You mind your own business," he said

"Just follow my sketch," he ordered

up against the guides, instead of down on the shoe, which made guides heat.

I learned that the oiling system originally was supplied from the crankcase. A scraper had taken oil off crankdisk rim and sent it through oil lines to the main journals, crankpins, crosshead pins and guides. But with the compressor turning in the wrong direction, there was no oil to scrape off. Hence, the homemade hand-oiling system. The tight belt, two tight bearings, and no flood of oil explained the hot bearings.

When I asked why the wrong direction, the old boy snapped, "Several of you young wise guys have asked me that. I've been running engines for 50 years and I never ran one turning under yet, and no engine I run is going to turn under. I know my business, so don't try to tell me nothing."

Compressor had suction-type inlet valves, which is the reason machine could run in either direction. I saw there was no use arguing, which accounted for not being fired that day.

At quitting time I met the superintendent. He wasn't friendly for the old compressor man had evidently put in a few words. But because I was the only compressor man available, the super said he'd try to put up with me for a few days. "But you better watch your step," he warned. I then learned that he and the old compressor man were leaving that evening; also, that the super would be back in a few days, but not the compressor man. Meantime, I was to take orders from a foreman.

Makes Changes. Departure of the super and compressor man was good news. After dinner, I headed for the compressor house. I removed the homemade oiling equipment, cleaned and replaced the regular system. Next, I removed the muck from the crankcases and filled them with new oil. I cleaned and restored the crankcase and crosshead covers. Also, I slacked off the main bearings and wrist pins because I knew they would run quietly as long as they were kept flooded.

I removed the belt idler. My biggest worry was that the excessive strain on the belt might have removed its stretch. Then, with the idler removed, it would not grip the pulley and flywheel. Last, I reversed the motor's rotation.

Machine Works. Very much to my satisfaction, the belt, when started up, showed no signs of slipping. As the compressor got up to unloading pressure, I saw she'd need some adjustments. However, as shutting-down schedule had been established, I decided to use it if necessary.

The compressor ran seven days a week, so I started her up at the usual time. About two hours later, the foreman asked when I wanted to shut down. I told him the compressor was running OK, and from indications any necessary work could be done on it at noon or in the evening. Also, that during work hours it would run right through without stopping. From this time on my main job was cleaning the motor, compressor, and inside of compressor house. Second evening I did give the inlet and discharge valves a going over.

When the super returned a few days later, he was annoyed at the changes I had made. But as the compressor ran quietly, and ran all day without giving any trouble, he let me alone.

The old compressor operator returned to town one evening some time later. But I packed up and left camp in time to avoid meeting him.

Here's a second chapter to this story. In 1921, I worked as draftsman for a large utility. One day an engineer handed me a sketch. It was a one-cylinder compressor, to be belt-driven by a squirrel-cage motor. What surprised me was that the compressor was to run over, and installation included idler with tightening screw. As motor was far enough from compressor, idler wasn't needed. I pointed this out and gave my reasons for compressor turning in opposite direction. The engineer listened without comment, then told me to follow the sketch. That compressor also had suction inlet-valves and double-babbitted crosshead guides, so it could operate equally well in either direction. But he told me to follow his plans.

When you consider how some compressors are installed and operated, and the unskilled men who often run them, it's remarkable they stand up. My experience has been that all machines are good, if operated as designed.

WILD GOOSE CHASES cost engine maker thousands of dollars that operators could avoid, but this firm wants happy customers

Flying Down Diesel Troubles

BY FRED CARTER, *Erecting Superintendent, Worthington Corp*

Tracking down diesel troubles is always expensive, but the operator can avoid many of these headaches. Often, it's just a case of making a slight adjustment, or of checking the serial number of a part before ordering. At times, I find the trouble after only a few minutes. Then again, I may have to do a lot of work before striking pay dirt.

We have several trouble-shooters on the road to keep customers happy. The four cases I tell about here show why this business isn't dull. And they may help you solve your own troubles next time something goes haywire.

CASE NO. 1: Dancing Needle Gave Operator Bum Dope

A plant owner out West sent a hot telegram demanding a serviceman at once. His wire said exhaust-gas temperatures fluctuated so badly he got unstable readings. He was afraid fault was with engine.

I hopped a plane that night and arrived in the wide open spaces next morning. A few hours by taxi over rough roads brought me to his plant.

Operator wasn't too happy when he met me, so I got to work. I turned selector-switch knob and, sure enough, pyrometer needle danced all over the dial. I was sure trouble was with instrument, not with engine.

First, I checked thermocouple connections at cylinders to see they were tight. Then I made sure connections were not crossed by checking plus marks on the thermocouple and pyrometer connections. They were OK.

I removed and inspected welded juncture of thermocouple leads—they were all right. Then I interchanged thermocouple connection with various pyrometer connections. They acted the same as when connected to their original cylinder. I heated one thermocouple element with a match, but needle still fluctuated.

There could be a partial break or fracture in wiring, so I retraced and rang out the wiring. But it was OK. Next came a check for wiring size, specified by maker for right readings. No mixup there. Selector-switch contacts were also OK. Only thing now was to look inside pyrometer.

I removed cover and operating mechanism—and found the gremlin. Grease, oil and dirt coated all parts. After cleaning them with carbon tetrachloride, pyrometer needle remained steady.

Engineer's face was plenty red when he saw I had made a costly trip just to clean a small instrument. But instruments are often needlessly scrapped and replaced when a little cleaning is all they need. It pays operators to know as much as possible about instruments also.

CASE NO. 2: Identical Transfer Pumps Only Looked Alike

A Southwestern plant sent an SOS. It was another long trip. This plant had two identical diesels. One worked swell, while other's fuel-oil transfer pump didn't deliver enough oil to support full-load operation. And being deprived of full-load operation didn't make the owner happy.

Suggestions had been made from time to time for bigger transfer pump. But since one of twin engines didn't need a larger pump, why should this engine?

I made all possible adjustments on engine to localize trouble source, but no luck. Then I checked fuel-oil pipe and tubing sizes. They were OK.

Customer did have a spare pump on hand, also a pump catalog. I checked listings and found maker had identical pumps as to size and appearance. I also learned that one had helical gears—while the other had spur gears. A little more checking showed me helical-gear pump was listed for engine of higher speed. Spur-gear pump's output was specified for speed range of engines in this plant. This was a clue.

I dismantled pump on engine that wasn't delivering enough oil for full-load operation. There was the trouble—it had helical gears, which catalog specified for higher-speed engine. Otherwise, both pumps were identical. Fortunately, customer's spare pump was right one for this engine. I installed it and solved the problem.

To avoid this kind of common trouble, make sure you read serial numbers correctly, right down to last letter. Often a letter after the number indicates speed range in an otherwise identical pump.

CASE NO. 3: Hot Bearing Showed Shimming Wasn't So Hot

A few years ago I made an emergency trip to the East Coast to find out why engine's outboard bearing ran hot. Customer wrote he did everything possible to cool it down, but no luck. Engine was large. Shaft through pedestal bearing on generator end was about 8 in. These bearings are self-aligning, seldom give trouble, so I was anxious to find the fault.

Bearing was sizzling hot—no doubt about that—but why? First, I checked lubricating splash-ring, then lube oil. OK. Then I made sure that oil level and oil characteristics were right for job—also, that oil was clean and oil rings were turning. I had to check everything.

Quick inspection of clearance around bearing housing and shaft showed shaft was not rubbing against housing. After questioning operator, I learned he had keyed up on bearing. Also, that he brought clearance between shaft and bearing with shims to our recommendations.

I stuck feelers between shaft and bearing without opening bearing. Clearance was OK. Next morning, I checked bearing while engine was started. One corner of bearing casing was hotter than rest of casing. But heat spread rapidly over entire casing. That gave me an idea. Self-aligning bearing was restricted or pinched in the casing so it couldn't align with shaft's movements.

Removing bearing casing-cover, I found upper bearing-cap that housed self-aligning bearing had not been raised through shimming to compensate for shim added between bearing halves. In other words, if shim is added between halves of such a bearing, it is no longer a perfect sphere (to move in its housing) but becomes oval. So casing that this oval-shaped bearing moves in must also be made oval, or bearing binds as it tries to wiggle slightly. After placing same amount of shims between bearing-casing halves as operator placed between bearing halves, bearing ran cool. Finding this trouble was easy.

CASE NO. 4: Engines Kept Conking Out Like Shot Rabbits

This case was a nightmare until I found the trouble. A Southern plant had several engines. Superintendent called long distance. I happened to be only a few states away, winding up a new installation, so I stopped off before flying home.

Super told me everything was fine until a few days before—then all hell broke loose. Seemed trouble was in fuel system. First, a fuel-oil pump failed. Then an injector nozzle clogged, stopping all fuel to its cylinder. As fast as one fuel injector was unplugged, another one in another engine would fail. Place was a madhouse, shutting down engines, cleaning injectors, opening fuel pumps and trying to keep sane.

I found minute brass particles lodged in precision parts of pumps and nozzles. Job was tracing source of these particles. With several engines conking out from time to time—that wasn't easy.

First, I opened a fuel-oil pump to see if brass particles could be from this source, but found nothing. Before long I was sure particles came from flexible connections in fuel-oil piping system. Connectors were between fuel-oil pumps and fuel-oil headers.

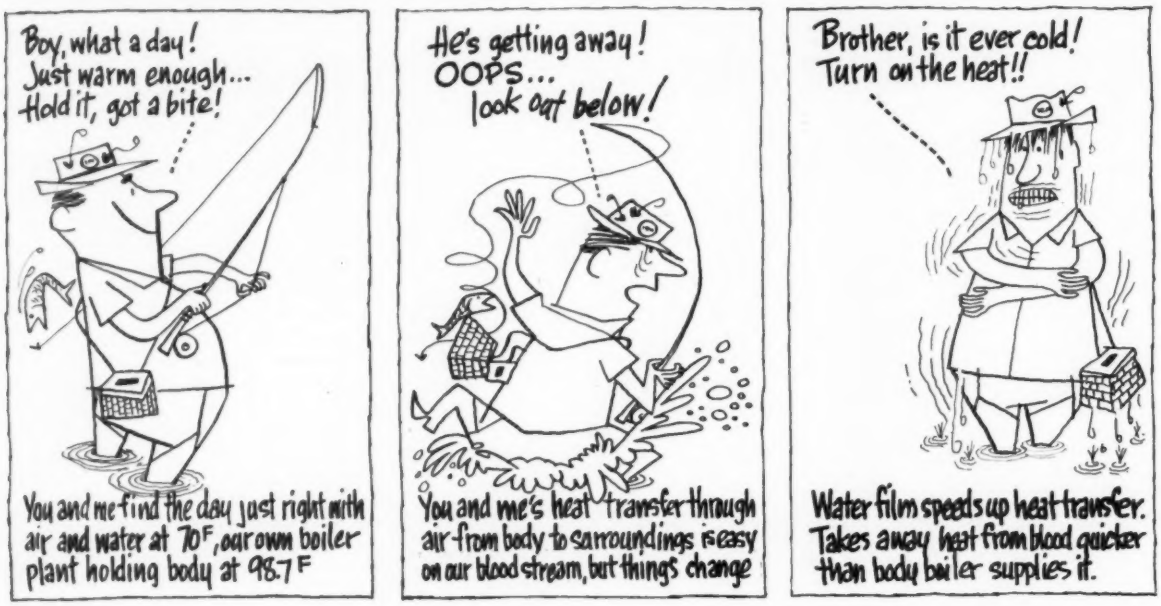
These connectors were 1-in.-dia tees, fitted with rubber gaskets for absorbing expansion and vibrations. Flexible gaskets had small brass springs imbedded at sealing edges. Brass springs in all connectors had started to deteriorate about same time, as all plant machinery was same age.

Evidently vibration in lines and sulfuric-acid action of fuel on brass caused the trouble. Only remedy was to pull out all connectors and replace with ones without brass.

I replaced all flexible parts of adapters with two neoprene O rings, held between two steel washers. They worked so well in this plant that we recommend them for all installations now.

Besides flying, and getting to out-of-the-way places by anything from a motorcycle to a row boat, our real fun starts when we enter your plant.

YOU AND ME: heat transfer runaway


Boy, what a day! Just warm enough... Hold it, got a bite!
You and me find the day just right with air and water at 70°F, our own boiler plant holding body at 98.7°F
He's getting away! OOPS... look out below!
You and me's heat transfer through air from body to surroundings is easy on our blood stream, but things change
Brother, is it ever cold! Turn on the heat!!
Water film speeds up heat transfer. Takes away heat from blood quicker than body boiler supplies it.

Fundamentals Solve Heat Troubles

By R H EMERICK, *Consulting Engineer, N. Charleston, S. C.*

► TODAY'S HEATING ENGINEER finds himself swamped with suggestions, devices, new heating systems every time he admits to a heating problem. These helps can take the form of anything from an improved trap or vent to the advantages of putting in a different heating layout—hot air, steam, high-pressure hot water, or what have you. When all's said and done, there's only one best way to solve any heating problem. That is, know all there is to know about your present condition so you can judge how good a job any proposed change will give.

We remember a couple of troublesome problems we ran into that prove our point. With them the answer could only come from going back to the fundamentals. For example, take the case of the blowing traps.

The traps in question were on the customer's connections near the end of a district steam-heating network. One cold day they began to blow like mad. When a serviceman finally got out to them they were behaving perfectly. An hour later, they were back at it again. Once we had a chance to see the traps acting up we knew it was an open-and-shut case—a loss of prime. But why? The reason was as simple as the fundamentals.

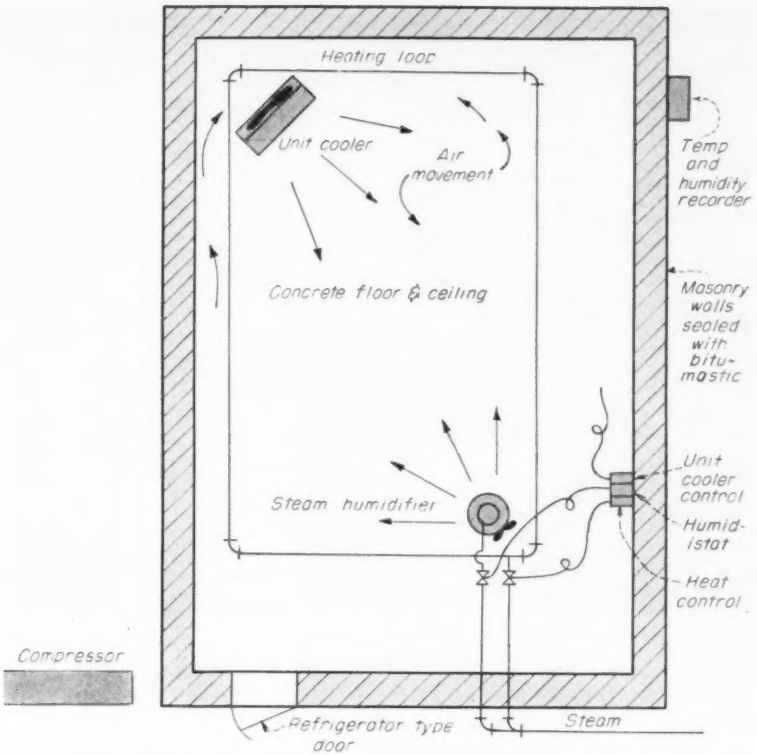
Heat Transfer. Most district heating companies try to supply the peak number of heat units. That means: Deliver as much steam and as little condensate as possible into the customer's lines. So these companies supply steam to their distributing mains with a little superheat. And, again, they do it for a reason.

Steam as we all know is merely vapor. Just pump it into a pipeline, no matter how well lagged, and you're bound to get condensation. To the district steam company this represents a loss of their product, heat energy, if it takes place within their lines. So they superheat it.

Superheat has considerable effect on heat transfer. It's just like dry gas, and it wants to remain in that state. It objects to rapid condensation and transfers its life's heat most reluctantly to the dry surface of the containing metal.

On the other hand, saturated steam provides a moisture film on the insides of enclosing pipes. That film works as a busy ally in heat transfer. If you've ever fallen into a pond, you know how well and how quickly this water film does its job. Take a look at the cartoon strip, "You and Me," at the top of this page. Dry, you were comfortable, but wet, you looked and felt like diamond floorplates with a shiver. When it comes to heat transfer, water acts on iron just as it does on us. Spill a little on an iron sheet at 100 F, and the water will grab up enough heat to evaporate fast.

As you might expect, there's pretty good evidence besides this rule-of-thumb estimate that the heat-transfer rate for saturated steam is higher than that of superheated steam. Actually, it's about twice that of superheated steam. So for the district heating company it's good business to superheat a little. But the user ought to recognize that and realize, if the load on the district steam-supply lines is light, he'll be getting superheated steam into his own heating system. Then coils, radiators and just plain pipelines will be-



HOT, HUMID ATMOSPHERE, ideal for curing concrete blocks, could not be set up in above room because fundamentals were ignored. Can you tell why? See the story

have a little differently than usual.

That's exactly what happened with our blowing trap case. When the load lightened on the district steam lines, the superheat increased a few degrees in our supply lines and condensate to the bucket traps dropped, at moments even disappeared. Without enough water for a seal the traps would blow like mad. A little later, along would come some slugs of wet steam, condensate would build up, the trap would seal, and everything was fine.

Trap Cure. Once we felt sure our trap trouble was priming loss, we made a quick and effective cure. We pulled off the insulating covering from a couple of feet of the drip leg to the trap, and left it off permanently. To produce condensate in a hurry, we sluiced cold water over the bare iron piping. But once we'd establish a seal and made sure enough condensation was forming by exposing the drip-leg piping, we never had a bit of trap trouble again—superheat up or superheat down.

If you're looking for a moral, it seems that you can have too much insulation on a working trap connection.

Our second case is more or less one of heating in reverse. It has to do with a special room built for curing concrete test blocks. We certainly didn't want to spray them for their 28-day curing period. Instead, we reasoned, we'd set up a 100% relative-humidity atmosphere at 65-70 F, and in that way produce a simple check on the drying rate. This method, we felt, would give uniform curing. To be certain of a 100% relative humidity we settled on establishing a definite fog.

Drawing, top of this page, shows the room we designed. A steam-type humidifier, with a fan for distributing the vapor under the control of an automatic humidistat, went in to produce the fog and maintain 100% relative humidity. If humidity fell off a bit, the humidistat turned on the steam. At 100% relative humidity, off it went. The job seemed that simple. Or so we thought.

Maintaining Humidity. We further equipped this room with a steam-heating loop and a unit cooler so the temperature could be kept between 65 and 70 F, winter and summer. A thermostat ran one or the other, depending on whatever heating or cooling was needed.

And so, with everything observed in working order, the room was put on test. The Freon compressor started up and cooled the room, the thermostat shut it off. But the steam refused to cooperate. It not only failed to develop a fog, but it also refused to produce 100% relative humidity. We then raised the pressure from 2 to 5 psig. Same result.

The humidifier manufacturer felt the trouble was originating in low steam pressure, a fouled strainer, or some such simple situation. The humidifier had always made fog before. In fact, in meat-storage rooms, fog is a nuisance.

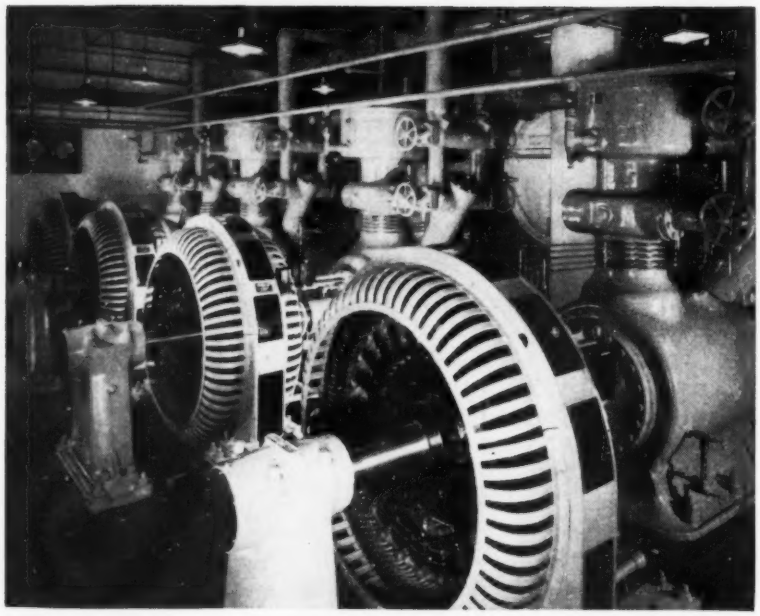
But as things worked out, the steam was cleared of all slurs on its good name. The real villain in the layout turned out to be the 55-F refrigerant in the coils of the unit cooler. As the fan circulated the vapor-laden air across these coils, the 55 F said in effect: "I am the saturation temperature of this room." And having so spoken it continuously condensed out all moisture above its own needs for 100% relative humidity. The doomed extra moisture just went down the cooler drain, the victim of a law of nature.

You can verify this law by referring the situation to a psychrometric chart. There, you'll see that 100% relative humidity at 55 F provides enough moisture for only 70% relative humidity at 65 F. And if we don't like the situation, we can put in a water spray, because nature won't break a law to help us cure concrete. So we put in a water spray, but remained scientific about it and turned the nozzle upward. This scientific arrangement now operates satisfactorily.

Because there is a reason for everything where steam is concerned, how come this humidifier successfully fogs up a meat room and yet flopped in the special room in drawing above? The meat rooms were chilled by coils with no helping fan to circulate the air rapidly. That fan made the difference.

The steam vapors remained comparatively static, and their passage across the condensing surfaces was much slower than the humidifier's speed of replacement. Also, as the temperatures in the meat room were quite low, around 32 F, far less moisture was required to produce a saturated atmosphere. To prove this point we need only remember that we can't see our breath at 90 F but can create a nice little cloud at, say, 45 F.

MORAL: If we want to keep up a fog with steam, we shouldn't run it through a condensing coil.



WELL-MAINTAINED refrigeration compressors seldom give trouble, stay on the job for years. Units in this plant are good example of what right maintenance will do

Make your refrigeration plant safer by learning how other operators got into trouble. Results of a survey pin down accident causes, show you how you can easily . . .

Cut Compressor Ills With the Right Upkeep

► YOU CAN AVOID refrigerating-plant accidents if you take a tip from the Hartford Steam Boiler Inspection and Insurance Co and pay attention to certain vital parts of your compressors. A survey of 150 accidents by this company shows where and why troubles occur.

Survey covers only commercial units rated at more than three horsepower. Ninety-six of the machines in the accidents were ammonia compressors, 54 were Freon.

Plants where the accidents occurred include cold-storage warehouses, breweries, hotels, dairies, packing and ice houses. The study is confined to the compressor only; it does not include accidents to motors or engines driving the machines.

Type. As a starting point in the survey, the accidents were classified according to the part that failed first, without regard to the damage that followed. For example, if a valve broke and then jammed between a piston and cylinder, the accident was classified as a valve failure. Or, if a bearing failed and scored the shaft journal, the accident was termed a bearing failure.

Fig. 1 shows that failures of valves and bearings, taken together, accounted for more accidents than failures of all other parts combined.

Valves. Next step in survey was to study and classify the 65 accidents caused by valve failures. In some plants the damage was confined to the valve or parts of its mechanism. But on many jobs, pieces of the broken valves jammed the machine, leading to breakage of pistons, cylinder heads or connecting rods. Repair costs ran as high as $1500 on some jobs, but the average was about $350.

Fig. 2 shows why these valves failed. Good maintenance could have prevented many of the accidents caused by valve cracks and loose bolts or fastenings. You can spot these faults if you inspect your machine regularly and are careful not to overlook any of the running parts.

Damage from liquid carryover, item 2 in Fig. 2, has many causes. These usually originate outside the compressor and can be traced to poor operating practices. So keep your expansion valves in good order at all times. Do the same for automatic controls of all types.

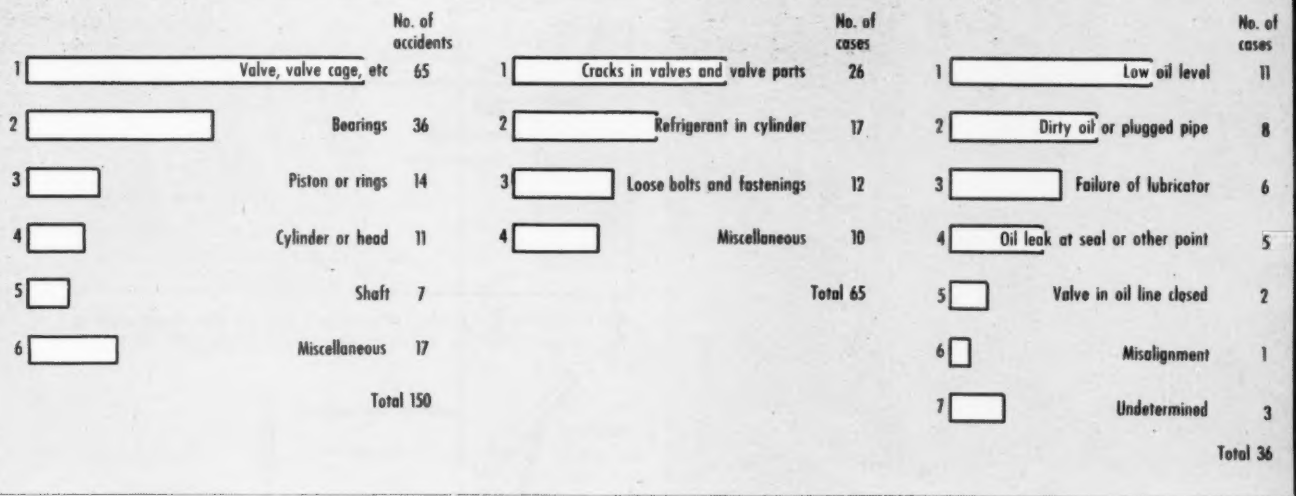
Always use the right starting procedure, keeping an eye and ear cocked for signs of carryover. Some machines give off clicking noises before enough liquid enters to cause damage. In some of the plants hit by these accidents, operators reported they heard the clicking noises on many occasions before final failure occurred. Remember, these signs of liquid carryover mean that trouble may be on its way.

Bearings. Most bearing failures among the accidents included in this survey resulted from lubrication troubles, Fig. 3.

As with most other types of machines, the chances of bearing failures in refrigeration compressors can be greatly reduced by a rigid program for checking lubricant supply and keeping it free of dirt and foreign matter. If such precautions had been taken, they could have prevented many of the accidents in items 1 and 2, Fig. 3.

Cost of these bearing failures varied widely, depending on whether (1) damage was confined to the bearing itself

Summarized Here Are Details of 150 Accidents in Refrigeration Plants Serving Many Different Loads


No. of accidents
1 Valve, valve cage, etc 65
2 Bearings 36
3 Piston or rings 14
4 Cylinder or head 11
5 Shaft 7
6 Miscellaneous 17
Total 150
No. of cases
1 Cracks in valves and valve parts 26
2 Refrigerant in cylinder 17
3 Loose bolts and fastenings 12
4 Miscellaneous 10
Total 65
No. of cases
1 Low oil level 11
2 Dirty oil or plugged pipe 8
3 Failure of lubricator 6
4 Oil leak at seal or other point 5
5 Valve in oil line closed 2
6 Misalignment 1
7 Undetermined 3
Total 36

1 Failure of valves, valve cages and related parts caused most accidents

2 Here's why valves failed. Cracks, liquid carryover were major causes

3 Bearings failed mostly from neglect of oil level, dirt in the oil pipes

or (2) the failure caused damage to the crankshaft, requiring replacement of this expensive part. Average cost for the 36 accidents in Fig. 3 was $720, but in some plants, cost of repairing the compressor ran to several thousand dollars.

Other Causes. The remaining accidents shown in Fig. 1, totaling 49, involved failures of cylinders, pistons, shafts, etc. They resulted from a variety of causes, and the number in any one classification is not sufficient to set a pattern. But two important points were noted: Liquid refrigerant entering the compressor caused 10 of these 49 accidents; and at least five of the cylinder failures resulted from lubrication troubles.

Learn From Others. Now what does this survey mean to you, the guy who's running a refrigeration plant of any kind? Briefly, valves and bearings should receive special attention in preventive-maintenance programs for refrigeration compressors. Leaving the survey, let's get down to some practical operating facts, as seen by POWER editors.

Check Your Plant. Machines that have thermostatic expansion valves sometimes become flooded with liquid during the off cycle. This is caused by incomplete closure of the expansion valve when machine stops. One simple way to avoid this trouble is to fit a thermostatically controlled solenoid valve in the liquid line ahead of the expansion valve. Then you'll get positive shutoff every time compressor stops.

There's no reasonable excuse for undetected cracks in valves, and their cages and other parts. Make valve examination a regular step in your maintenance program, using a magnifying glass to help spot suspected cracks.

First sign of leaking or broken discharge valves is usually a rapid rise in suction pressure after machine stops. On Freon systems, a suction-pressure rise of more than 5 psi per minute indicates that discharge valves leak or are broken. But before opening compressor to inspect valves, save yourself some work and check expansion valve, solenoid stop valve and relief bypass for leaks. Leaks at these points can make suction pressure rise quickly.

Lubrication. If you have the right oil for your compressor, there's no reason why it shouldn't give good service for long periods. So tackle the lubrication problem by checking to see if your oil is suitable. Reciprocating ammonia compressors generally use 150-300 ssu oil; Freon compressors take 280-300 ssu oil. Both these recommendations are for smaller units. Viscosity is that measured at 100 F. Consult a lubrication engineer for best viscosities in large units.

Note in Fig. 3 that most bearing failures resulted from neglect to keep right oil level. Leaks, plugged pipes, defective pumps and not enough oil will cause level to fall too low. Make an hourly check on lubricant level while machine runs. Check again before machine starts.

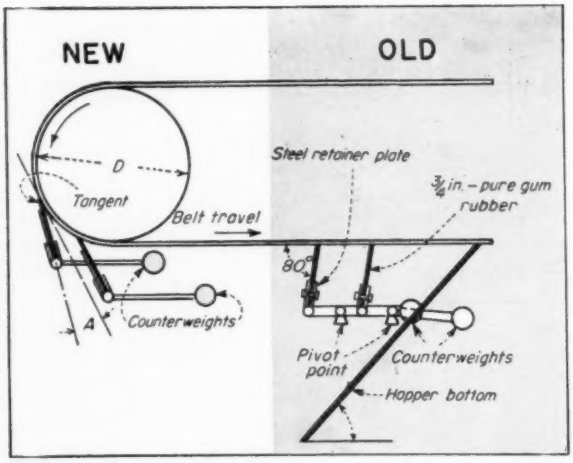
To remove water and dirt from lube oil, use a separator. Clean it regularly; a dirty separator is almost as bad as none at all.

Ring-oiled bearings must always have enough oil in their reservoirs so ring dips into it. This applies to chain-oiled bearings also, because the only major difference in the two designs is that the chain replaces the ring.

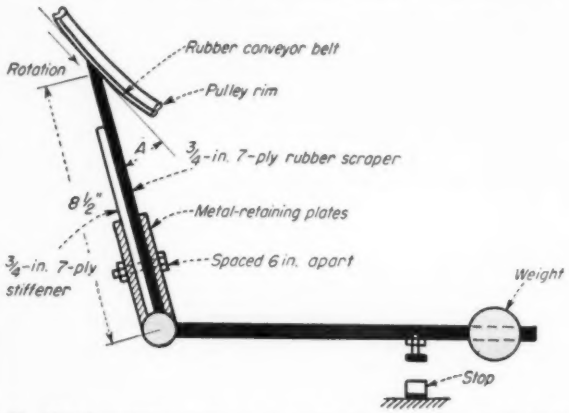
Check sight-feed lubricators every hour while compressor runs. Count the drops fed, using a stop watch to check feed rate. Refill lubricator reservoir before level goes out of sight in the gage glass. Don't skimp on oil feed rate—you may save a few pennies today and spend hundreds or thousands of dollars for repairs tomorrow.

If your compressors are splash lubricated, be sure to choose an oil with a high-enough viscosity at compression temperature to prevent excessive oil consumption. Oil that is too light gets by the piston rings and mixes with the refrigerant. See that oil is stable and resistant to oxidation. This keeps carbon and gum formation low, prevents plugging of oil passages.

1 Occasional check on conveyor-scraper counterweights assures correct pressure is applied by scraper against belt



2 Changing the angle between belt and scraper, then shifting scraper location, brought end to annoying belt chattering



3 Metal-retaining plates are made short so they won't bind on conveyor if the scraper turns over; belt might be ripped

Small Changes Lick These Conveyor

• Plant-made improvements on this coal-conveyor scraper show how operating ingenuity can often get the best of knotty problems in your equipment design

• Here Jim Campbell, boiler-room engineer at Detroit Edison Co, tells each of the steps they've gone through and the success they've had in ending chatter, reducing maintenance

► SLIGHTLY INCLINED, coal-belt-conveyor scrapers, installed in Conners Creek powerhouse, met with moderate success. But plant-made improvements have worked even better. Original scraper setup, Fig. 2, was used in some 49 locations, most near head, but some near tail pulleys.

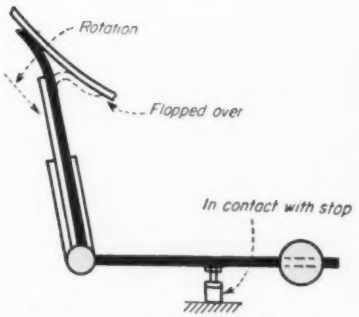
Belt Chattering. When this type scraper removes coal, it "rolls" the coal under scraper belt, dropping off on downstream side of scraper. Because of this rolling action, sufficient space was always left between hopper sides on scraper so coal could fall below. We found angle of hopper should be over 60 degrees to allow scraped coal to slide more freely.

Original double-scraper is still used in many locations, as at either end of reversible conveyors. Here, on these reversing applications, minor chattering was often noticed.

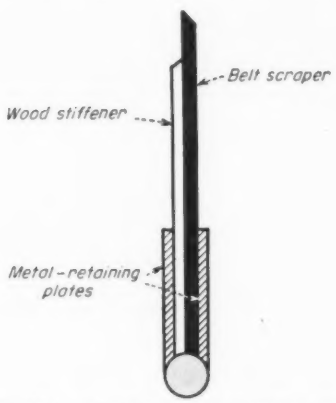
To lick the chattering problem, angle of contact with belt was reduced, Fig. 2. Changing the angle and placing scraper in contact with belt, at point where belt passed over pulley, made a marked improvement in scraping. Reducing angle *A* was of major importance. Following table lists most efficient angle *A* (scraper to pulley tangent) for various pulley diameters.

Pulley diameter, in.	*Angle A, deg*
24	20
36	25
42	27
48	30

Present Scrapers. Present scraper, Fig. 3, using 7-ply ¾-in. rubber, was field-tested, and no excessive wear or



4 Softening of scraper-rubber may cause flopover, even with proper stop



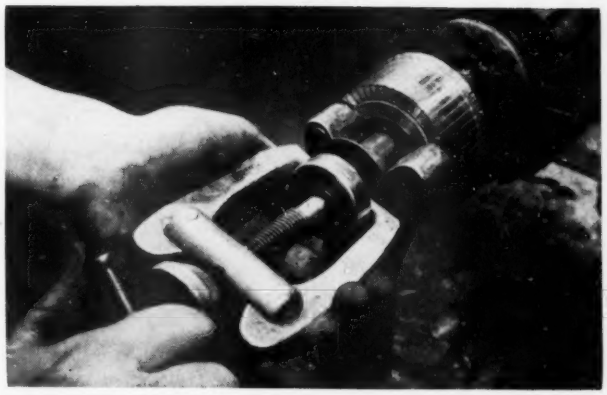
5 White pine gives better stiffness, carries off heat faster than ply-rubber

Problems

burning was noticed. We've found ply rubber gives better scraper stiffness. Stops were placed on the weight lever to prevent scraper from flopping over, plus giving simple indication as to scraper wear.

Metal-retaining plates, Fig. 3, are made short so they won't bind on conveyor if scraper turns over. Otherwise, if plates were too long, belt could be ripped or burned. Even with proper stop-setting, scraper occasionally flops over. We trace this to heating of scraper rubber, causing it to soften and conform to pulley, Fig. 4.

But this last problem has apparently been licked with a still newer design, Fig. 5. Here, white pine replaces the ply-rubber stiffener. White pine conducts heat away twice as fast as rubber and gives better stiffness.



Noisy Bearings Up Maintenance

► FOR A REALLY QUIET BEARING, the balls, inner and outer races must be highly polished and regular. Races must be perfect circles and balls perfectly spherical, all dimensions held to close tolerances. And such is the case with a bearing from a reputable manufacturer. Noise problems generally come from poor installation.

All the topnotch workmanship the manufacturer put into the bearing can be ruined by poor fitting and careless installation. Ruined from the noise angle too. For example . . .

Shrink Fitting. For bearings larger than the one above, it's not uncommon to shrink-fit by preheating the bearing in an oil bath or oven. Trouble comes when shrinking takes up the designed internal bearing clearances. When bearing operates, the inner race tries to expand. Where the internal clearance has been taken up by shrinking, you come up with a "preloaded" condition. This shows up by bearing being noisy, and generally results in early failure.

In any normal ball-bearing setup about 70% of shaft-diameter excess is translated into expansion of inner race. This, in turn, means a corresponding decrease in internal clearance.

What is good practice? As we see it, there's little disagreement on the need for a reasonably tight fit between shaft and inner race. At the same time, undue squeezing of bearing on shaft must be avoided. From the noise angle, a bearing with a medium-to-loose internal clearance is preferred for motor applications.

But if you shift to the other extreme—excessive clearance, especially if accompanied by critical operating conditions and unfavorable balance—you may wind up with "shaft whip" or progressive gyration of shaft around bearing's internal clearance at a fast clip. Mechanical vibration results with a vibration frequency having no apparent relation to speed or other factors.

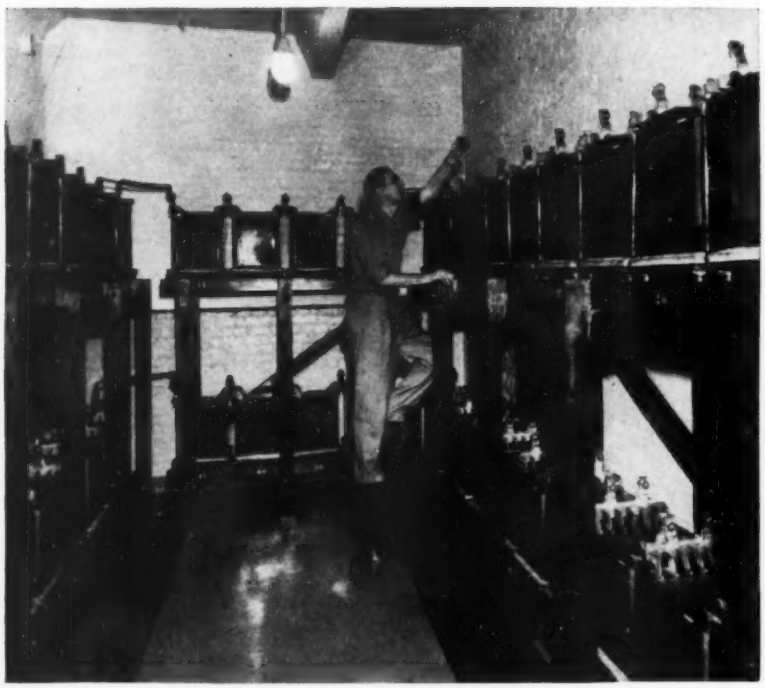
Where you run into such a condition, the vibration can be damped with an axial-thrust washer, which applies a thrust load to outer race of one bearing while taking up internal clearances of both bearings. The bearings are then lightly spring loaded. Stabilizing washers of this type are available from several manufacturers.

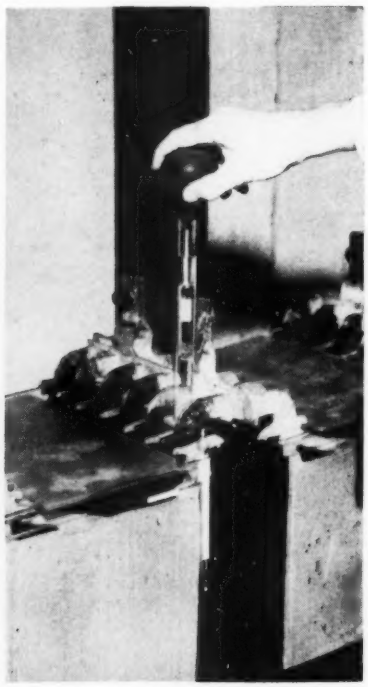
Bearing Housing. Fit between bearing housing and end bracket should be snug, but not to the point where the outer race is distorted, knocking out alignment with the ball track.

Cleanliness is a major consideration in handling ball bearings. This is the first rule laid down to any apprentice in a repair or maintenance shop. Noise and early failure stems from dirt, grit or foreign matter reaching the ball track.

—JIM SPARKS, *St. Louis, Mo.*

PRACTICAL IDEAS...*here's the trading post for your*





How Good Charging Methods, Maintenance Stretch Battery Life

LIFE RECORD of 62-cell battery installed in 1918—35 years ago—in Blue Island, Ill. station of Public Service Co of Northern Illinois, shows how good charging methods and maintenance can stretch battery life.

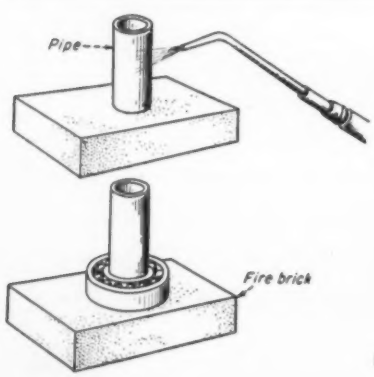
First 12 years, this battery was recharged by "cycle charge" method recommended at that time. Beginning in 1930, battery has been charged by "float charging," preferred at present.

Since installation, battery has received a 4-step maintenance inspection: (1) Voltage of each cell is checked every three months. (2) Over-all voltage of entire battery is checked daily. (3) Periodic check is made of panel meter against a standard meter. (4) Specific gravity of each cell is checked monthly.

Written record is kept of all points checked. Deviations from normal are easily caught and remedies immediately made. Cell repairs are also recorded. For instance, repair records show that in first 15 years, 96 separator repairs were made. This is one separator repair per cell, every ten years. Ever since the float-charging method has been in use, there's been a sharp decline in number of repairs.

Battery is used for oil-circuit-breaker control, power for indicating lights and emergency lighting. Test in 1941 revealed that battery gave better than 100% capacity, also that only one cell showed any deviation from normal—but not until end of discharge period.

Maintenance department reported in 1942 that battery would give ten more years of service. It's still going strong. *Courtesy, Gould National Batteries, Inc*



Expanding Ball Bearing

SKETCHES SHOW quick way to heat a ball bearing before expanding on a shaft. First, take a short piece of pipe that fits inside ball bearing. Then stand pipe on end on a brick and heat pipe with torch. Slip ball bearing down over pipe so it also rests on the brick. Heat radiating from pipe expands bearing. It is then slipped in place over shaft.

H C POOLEY *Wilmington, Del.*

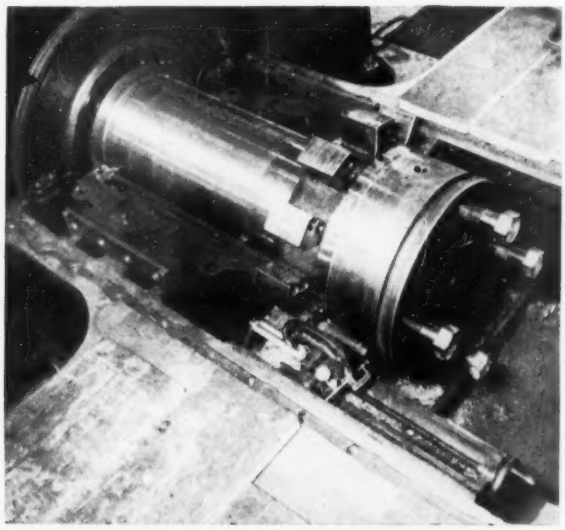
Make Paper Work Easy

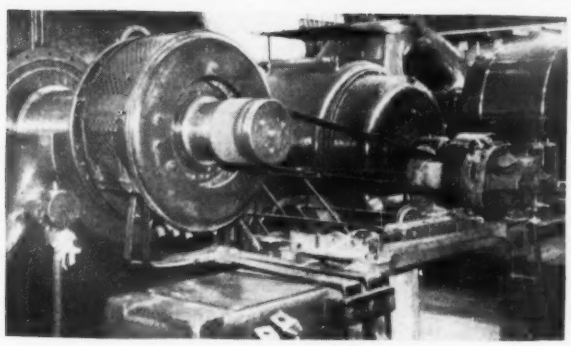
GUYS WHO THINK paper work is labor, as I do, should make graphs to speed this unpleasant chore. Plot manometer reading against gas flow, for example —and gas-flow or steam-flow efficiency. If an operator can figure quickly just what he is doing, he is more apt to do his best. We have good luck with this visual method of speeding work.

H HOLCOMBE *Los Alamos, N. M.*

operating and maintenance short cuts

STEVE ELONKA, *Associate Editor*





Turning Down Generator's Shaft Ends in Place

DURING TURBINE INSPECTION and repair periods, we had to renew bearing-ring segments that support flexible coupling on the shaft ends of the turbine and the generator.

After old segments were removed and new installed, we had to turn down new rings to size. This called for some kind of a turning device to turn turbine and generator shafts, as well as a cutting-tool rig to turn rings to size.

Photographs show how we rigged an air-hoist motor to turn rings down on end of generator shaft. They also show compound rest bolted to inside of center bearing pedestal to hold cutting tool for turning rings to size. Dial indicator was used to check shaft movement while machining segment rings.

To turn rings down on turbine end of shaft, same turning rig was used. On generator end, exciter armature was removed from generator shaft for repairs, and this made it quite easy to turn shaft.

On steam end, emergency governor was removed from shaft end and a pulley fastened by bolts. We used bolt holes that bolted emergency governor assembly to end of turbine shaft. This work was done on a 25,000-kva turbine generator which runs like new.

E E SMITH *Clarks Summit, Pa.*

For Clean Drawings

TIE YOUR SANDING BOARD END to a 3-ft piece of string, tacked to side of drafting table. Then it will always be handy, and your drawings won't get smudged with pencil carbon dust.

ED ECKERT *New York, N. Y.*

Keep Your Coffee Hot

COFFEE STAYS right temperature if you keep coffee pot on a steam trap.

H HOLCOMBE *Los Alamos, N. M.*

Finding Condenser Air Leaks by Easy Method

FINDING condenser air leaks comes up often, and locating exact trouble spot can take a long time. This fast method works well for checking turbine gland seals and other points in areas that cannot be visually observed.

We used a Prest-O-Lite halide detector. This is a small burner arranged to pull primary combustion air through a tube and into burner. Flame is a pale blue if only air is pulled into burner through suction hose. If small amounts of vapor from carbon tetrachloride enter suction tube, flame turns green.

Torch was developed to detect leaks in refrigerating equipment using organic halides as refrigerant. But since these materials are not always available around a power plant we tried carbon tet. Vapors from this liquid color flame.

Find condenser air leaks by placing burner where (1) it burns with a small, steady flame (2) suction hose can be placed inside exhaust air line from after-condenser on air ejectors or vacuum-pump discharge line.

If used for first time, test to observe reaction of flame when carbon tetrachloride vapor is present in air entering suction tube. A few drops of carbon tet may be added through the vacuum-breaker valve. After a few seconds, flame on lamp shows a greenish color.

After this experiment, use a pint-size pump oil-can to pump carbon tet on any joint or seal to be tested. With suction tube of detector in air-exhaust line, pump a few drops of carbon tet on a suspected point. Then observe detector flame for 30 or 40 seconds. Greenish discoloration in flame tells carbon-tet vapors are present in air exhaust of ejectors. If carbon tet is confined to a small area or a single connection, you can almost pinpoint a leak. Make double check by waiting for flame to clear. Then use another carbon-tet shot on same area.

Remember, carbon-tet vapors are toxic. Never use unless place is well ventilated. Continued exposure to vapors is dangerous. Brief persons using this material so testing is safe.

P H RENFORE *Borger, Texas*

(*Continued on page* 150)

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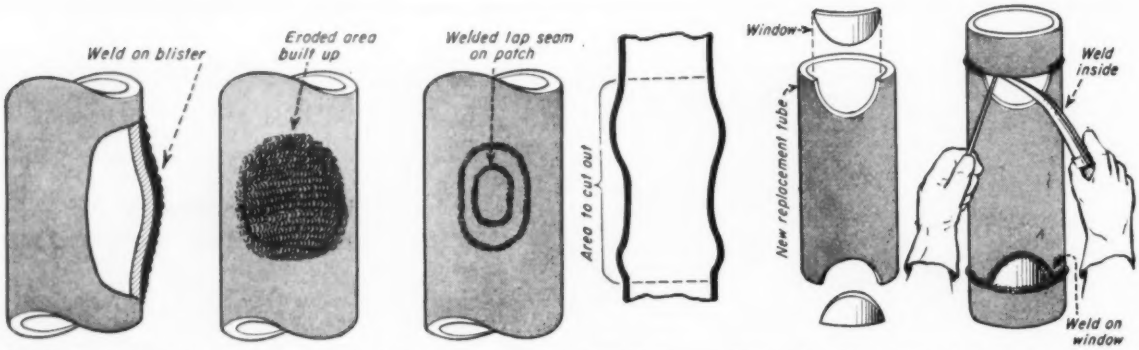


WRONG: Blistered tubes repaired like these will soon fail **RIGHT:** Remove blistered sections and 'window-weld' as shown

Window Welding Can Save Your Blistered Boiler Tubes

BOILER TUBES often fail and boiler must be taken out of service quickly.

Here are some causes of tube failure: (1) scale or heavy sludge on tube wall (2) oil adhering to tube (3) soot blower out of line, steam impinges on tube (4) plugged tube (5) flaw in tube (6) bad previous weld.

Repair by window welding is quick, economical, and it's a permanent repair. Ruptured, bulged or thin tubes have been repaired temporarily, as shown, but they will fail again.

Repairs fail sooner or later from (1) localized welding stresses (2) cracks forming between weld beads or (3) weld making metal double thick, thus keeping away cooling effect of water.

Window welding is easy and as quick as these temporary repairs. First cut out damaged tube section. If tube has scale or oil blister, there's usually a smaller blister a short distance from failure. Cut out smaller blister also. After all damaged areas are cut out, square off tube end and grind to 30-degree angle on inside, all around. Cut new piece of tubing to exact length of piece removed from tube. Grind each end of this replacement piece.

If you could weld each boiler tube completely around outside, while you are inside a boiler, no window would be needed. But other tubes are usually too near. So cut a so-called window on replacement sections at ends.

Then cut out "window," or cut off a piece so replacement piece can be welded. First, cut out a half circle of about 2-inch radius and about two-thirds of tube's circumference in diameter. This opening gives plenty of room to weld inside tube, two-thirds of the way around. Now set wedge-shaped window in place snugly and weld solid from outside.

After damaged tubing is cut out and cause of failure found, treat boiler so scale or oil is removed before placing boiler in service. That means turbining all remaining tubes and descaling drums, or boiling out boiler with caustic solution to remove harmful oil.

BILL DAVIS *Chicago, Ill.*

CLIP-ON CAP of gallon can is punched with hole. Solder metallic hose in place

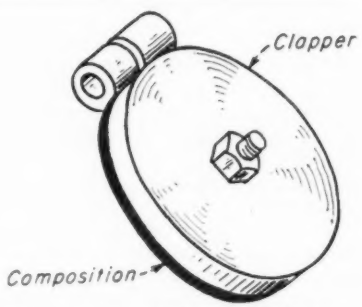
'No Spill' Oil Container

WE USE SPECIAL GRADES of lube oil from 1-gallon cans. Machines are oiled by squirt-type oil cans or small, pressure oil-guns. But filling small oil cans from 1-gallon can isn't easy.

Photo shows how we solved problem. Clip-on cap of gallon can is punched with hole in center. Solder a small-bore, flexible, metallic hose in place. It's easy to tilt can and guide narrow stream of oil into a small container. Oil supply is cut off quickly when hose end is bent upward. And you don't require hole for air entry to take place of oil removed because only a little oil is drawn off at one time.

When punching hole in cap, apply punch on concave side to keep from damaging snap-on cap. When gallon can is empty, place cap with its hose on a new can for more service.

C T BOWER *London, England*



Stop Noisy Check Valve

INSERT a composition disk—same as used on water end of hot-water pump. Take clapper out and drill 3/16-in. hole in center. Make ¼-in.-thick disk, same size as clapper. Screw clapper on with 3/16-in. stud and lock washer. It does the trick. Have one ready for replacement so repairs are not held up.

E R ROSE *Detroit, Mich.*

(*Continued on page* 152)

Used in the Most Prominent Buildings

Cram & Ferguson, Architects
McCarron & Sullivan Co., Plbg. Engineers; M. Ahern & Co., Contractor
Buerkel & Co., Heating Engineers & Contractors

POWERS

WATER TEMPERATURE CONTROL

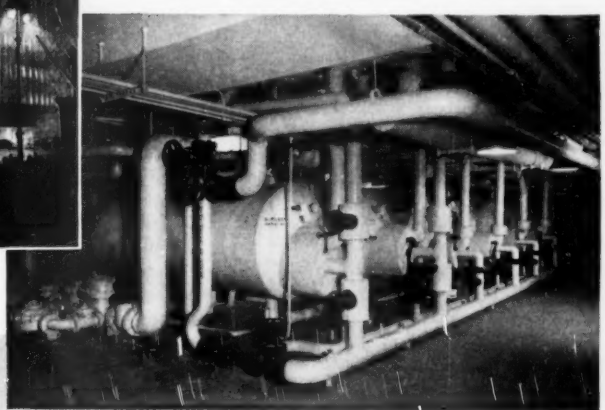
In Boston's Famous Landmark

John Hancock

MUTUAL LIFE INSURANCE COMPANY BUILDING

Water Heaters, six of which are shown below; 21 Shower Baths; 7 Dishwashers in the company cafeterias; Photostat Developing Baths for two large photostat machines . . . all are regulated by various types of POWERS Thermostatic devices especially suited for their particular use.

When problems of temperature control arise phone or write POWERS nearest office. With over 60 years' experience and a complete line of controls, some of which are shown below, we can help you find the right solution for your requirements.



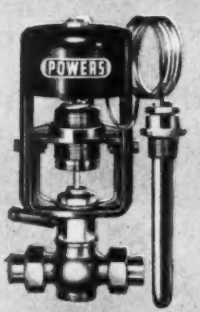
Powers ACCRITEM Regulator

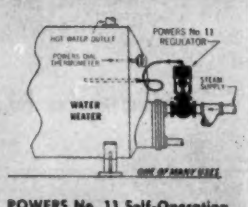
Compressed air or water operated for controlling all types of water heaters, and diesel engines.

Powers FLOWRITE Valve

POWERS Thermostatic Water Mixer. Insures utmost comfort and safety in showers. Many other uses.

POWERS Easy to Read Dial Thermometer





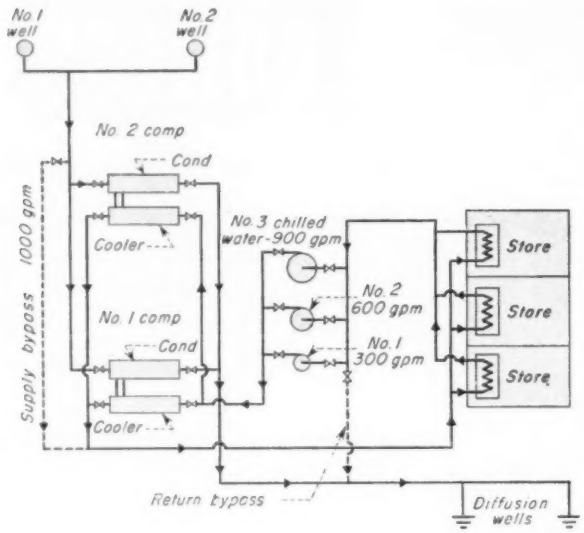
POWERS No. 11 Self-Operating Temperature Regulator for water storage heaters, hot water converters, dishwashers, fuel oil preheaters, jacket water cooling for air compressors, and diesel engines, etc.

(b29)

Established in 1891 • **THE POWERS REGULATOR COMPANY** • SKOKIE, ILL. • Offices in Over 50 Cities

More PRACTICAL IDEAS

Begins on page 148



Beating the Demand Meter

OUR CENTRAL air-conditioning plant serves shopping area, including large store, two banks, a super market, two restaurants, bowling alley, theater and about 20 small shops. Maximum load is 1000 tons.

Plant has two 600-ton centrifugals, driven by 600-hp 4160-volt wound-rotor motors. Condensing water at 54 F is supplied by two 500-gpm deepwell pumps. After passing through condensers, water is returned to same aquifer (well) it's taken from, but downstream so there's no chance of recirculation.

Chilled water at 45 F is pumped at varying gallonage to maintain differential between supply and return of 10-12 F. Minimum is 600 gpm, but various pump combinations can increase it to 900-1200-1500-1800 gpm.

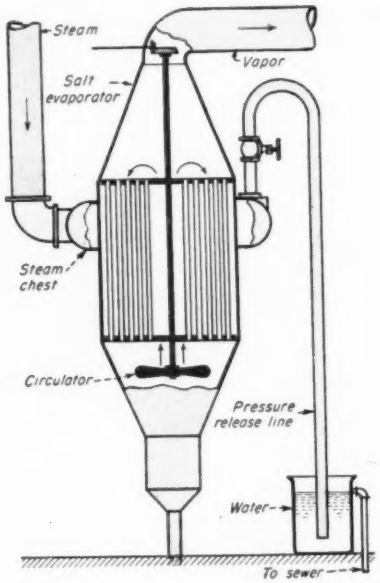
Because of private utility operation, chilled water is pumped from 7 am to 2 am from May 15 to Nov 15 to meet consumers' requirements.

Because of motor's size, there's a heavy demand charge. We learned during first operating season that load during May, June, Sept, Oct and Nov was light, as weather was cool. But demand charge was imposed if motors were used only a half hour during month.

We figured we could obtain about 400 tons of cooling from 54-F well water, but could not get much dehumidification. But then humidity during these months is usually low. We installed a bypass line so the well pumps discharged directly into chilled-water loop, sketch. Another bypass diverted returns back into diffusion wells.

Results were very good. We cool with well water during May and June, use compressors during July, Aug and Sept. We return to well water during Oct and the few days in Nov that require cooling. Job more than paid for itself in one season, saving demand charge for four months as well as reducing energy charge which all adds up to savings.

W J STEINERT *Flushing, N. Y.*



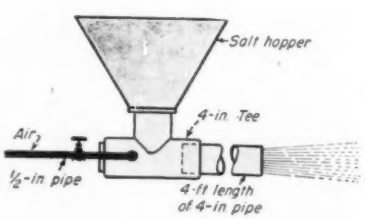
Pressure-Release Line Serves as Safety Valve

OUR SALT EVAPORATORS at this salt plant did not have any way of releasing pressure in steam space. Under normal conditions they are placed under a vacuum.

Steam space is under considerable pressure at various times, because of abnormal conditions.

Since shells of those vessels were designed to operate in a vacuum, this could cause a dangerous explosion. With no safety device available, I tried the foolproof idea in the sketch. This cost us very little money and works swell.

D JENNINGS *Sarnia, Ont.*

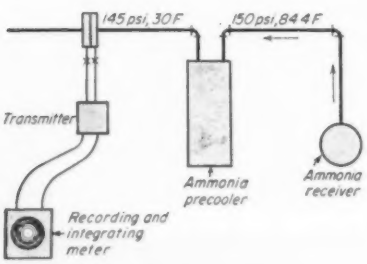


Moving Dry Salt

WHEN OUR BULK-SALT STORAGE became filled so our present conveyors couldn't fill remaining space, I made the blower in sketch. One man can handle this apparatus. Salt can be blown in any direction and needs little or no attention. It can be used for any dry, free-running material that causes trouble.

D JENNINGS *Sarnia, Ont.*

How to Meter Liquid Ammonia



SKETCH SHOWS a good method of metering liquid ammonia. Water is calibrated directly in tons of refrigeration. Previous attempt to install orifice plate on outlet side of precooler was unsatisfactory because of the "flash gas" problem. It is not necessary to precool to this low a temperature but to about 10 degrees below condensing temperature corresponding to system head-pressure.

M E EVANS *Chicago, Ill.*

IT FLOATS ON THE LOAD! *

You turn on the steam.

This little stainless steel valve—the only moving part in the Yarway Impulse Steam Trap installed on the equipment—opens wide and *stays* open as the air and condensate continuously pour through.

The equipment reaches production temperature in the quickest possible time.

Production temperature reached, the little valve snaps shut. After that, by a pulsating action, it discharges all condensate as it forms—even a tiny teaspoonful. *There's hot steam in the equipment all the time . . .* steady, maximum temperatures are maintained.

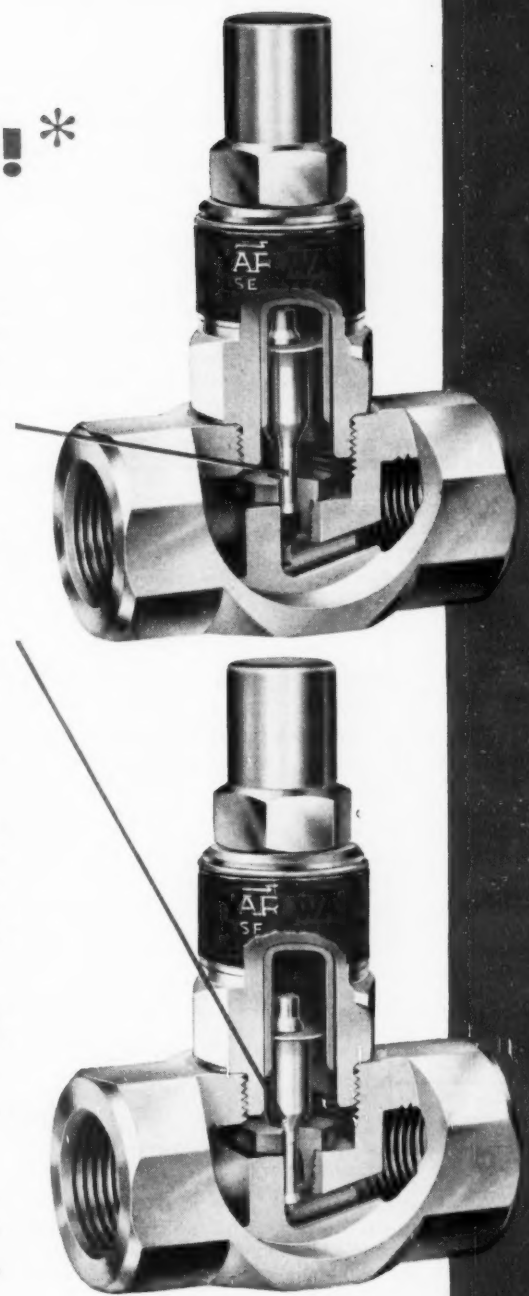
It all adds up—to more production per day.

Other profit-making features of the Yarway Impulse Steam Trap—low initial cost, easy installation, stainless steel construction, low maintenance, good for all pressures, quick delivery from over 200 local industrial distributors.

Try a Yarway—free for 60 days—and *prove* its advantage. Your distributor will supply you.

For free Yarway Impulse Steam Trap Bulletin T-1740, write . . .

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.



* *. . . resulting in fast heat-up of equipment, more production per day.*

YARWAY | ***impulse steam trap***

PLANT PROBLEMS... *put your know-how to work*

How Can I Regulate Process-Water Pressure?

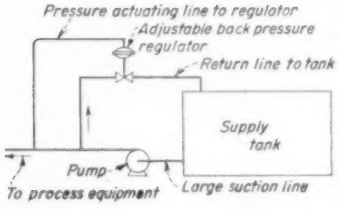
HERE ARE THE FACTS: Our process work requires a water pressure of 30 to 31 psi. We have no elevated tank or pressure source other than a double-suction centrifugal pump that takes water from a tank mounted on the plant floor.

When direct-connected to a 1000-rpm motor the pump discharges at 19 psi. Connecting it to a 1600-rpm motor gave a discharge pressure of 35 psi, which is too high.

We've tried throttling the pump discharge valve, but this often reduces quantity below what we need. Storage tank can't be raised above its present position in the plant.

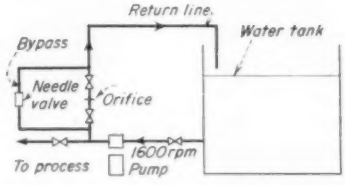
What's best way to control this pressure? Suction line runs level from tank into pump suction. Distance between pump and tank is about 2 ft. Discharge line runs horizontally to the process units. Neither line is pitched.—*DN, July Power*

Here Are 22 Answers



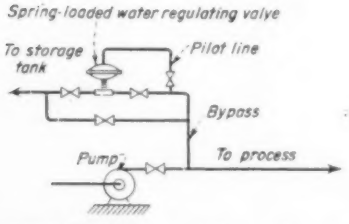
SIMPLEST WAY to solve this problem is to use motor that gives greatest capacity and the piping hookup in the sketch. Regulator controls return of water to tank, keeping process pressure at the desired level. Be sure suction line is sized correctly for pump capacity.

T H McCarthy
San Francisco, Calif.



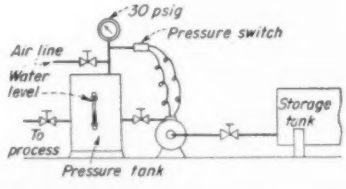
HOOKUP in sketch will give desired pressure if orifice size is varied until correct diameter is obtained. Fit bypass with a needle valve to permit operation while orifice is out of service for any reason. It may also be used when process-water needs vary widely from normal demand of the system.

F R Anish *Milton, Mass.*



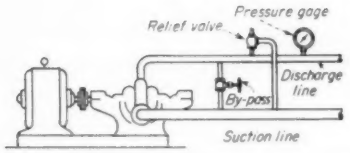
SPRING-LOADED regulating valve, installed as in sketch, will do *DN's* job for him. Place valve close to pump and make it the same size as the pump discharge line. Valve operating range should be 25 to 40 psi. Adjust spring to maintain a constant pressure of 31 psi in pump discharge line. If water quantity delivered at 31 psi is too small, either the pump or the discharge line, or both, is too small.

John J Geist *Brooklyn, N. Y.*



IF FLOW is steady, use a steam pump with a constant-pressure air-controlled governor. Where pump capacity is considerably greater than demand, close pressure regulation can be secured with an air-filled pressure tank, as in the sketch. With pump capacity only slightly greater than the demand, use a spring-loaded relief valve on pump discharge to control pressure.

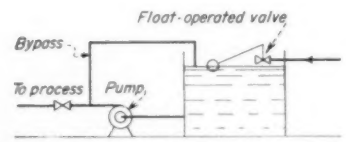
Howard Holcombe
Los Alamos, N. M.



THIS TROUBLE is a common one with motor-driven centrifugal pumps. *DN's* best solution is to bypass some water from the discharge to the suction line, as in sketch. This lowers the discharge pressure and increases the quantity pumped. Relief valve will do the same job automatically once it is properly set for the pressure desired.

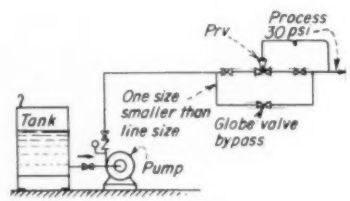
Check to see motor is not overloaded when using a bypass or a relief valve. Some pumps draw excessive currents when discharge pressure is lowered only a few psi.

George Griffel *Bronx, N. Y.*



FLUCTUATING level in floor-mounted tank affects suction head on the pump, causing varying flow through throttled discharge. With this condition *DN's* best bet is to install a float-operated valve in tank supply line to maintain level with 6 in. of desired line. Sketch shows the hookup that is good.

A E Pritchard *St. Louis, Mo.*

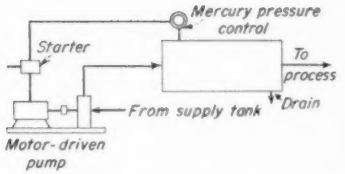


IMPELLER, trimmed so its diameter is less than formerly, will produce a lower discharge pressure. Instead of trimming impeller, *DN* can order a new impeller having the diameter needed to give the desired discharge pressure. Keep the old impeller on hand for possible use if conditions change. Sketch shows best piping hookup with new impeller, pressure-regulating valve (prv).

John Constance
Cliffside Park, N. J.

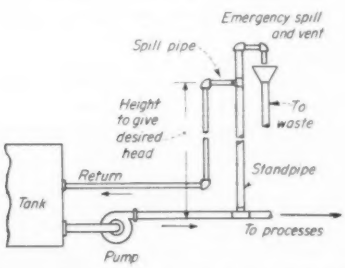
help the other guy cure his headaches

TYLER HICKS, *Associate Editor*



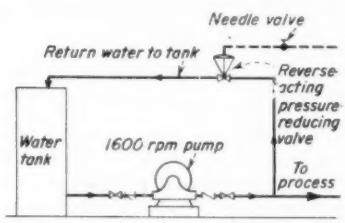
MERCURY SWITCH, connected to a pressure tank as in sketch, provides pressure desired in process system. Use a switch with a differential setting range to actuate motor starter.

A A HUNNEWINKEL
Woodstock, Ill.



STANDPIPE, as in sketch, is good if *DN* has enough room for it and there is no danger of freezing. Have pipe high enough to give a static head of 31 psi. Emergency spillover prevents excessive pressure if process water is suddenly shut off. Vent relieves air and prevents siphon action in the spill line.

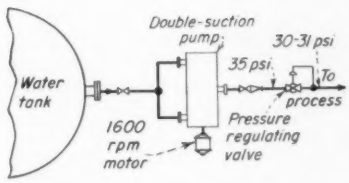
A H MOULTON *Pittsfield, Mass.*



REVERSE-ACTING pressure-regulating valve, installed as in sketch, solved a similar problem for us. Pump discharges at 35 psi when run at 1600 rpm. Reducing valve, which is set to maintain a pressure of 30 to 31 psi, allows excess water to bleed to supply.

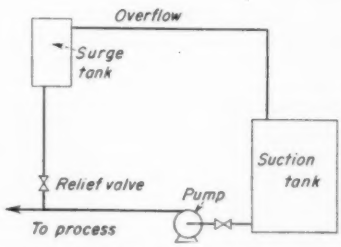
Install a needle valve in control line to diaphragm to prevent pulsations in prv from sudden surges. Adjust its opening as necessary, avoid over-sizing.

H A BERSON *New York, N. Y.*



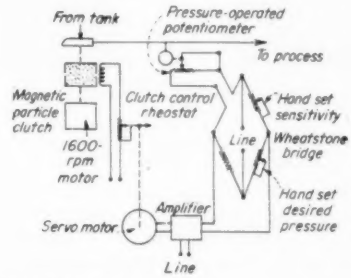
USE a pressure-regulating valve (prv) in pump discharge piping, as sketch shows. Then the 1600-rpm motor may be used to drive the pump. Double-seated valve gives closer pressure regulation than a single-seat design.

A J BREUGELMANS *New York, N. Y.*



USE SURGE TANK as in sketch. Locate it high enough above pump discharge to give the desired pressure in the line to process units in the plant.

HENRY RASMUSSEN
Crystal Lake, Ill.



STANDARD SOLUTION for *DN's* problem is a larger pump discharging into a pressure tank with an air cushion. From this tank the water flows to process units. Pump is controlled by an on-off pressure-operated switch and tank discharge is throttled by a prv.

An alternative that uses the existing pump has a magnetic-particle clutch between motor and pump. Pressure is controlled by varying pump speed.

R A DENNING *Bronx, N. Y.*

IN OUR PLANT we need higher water pressure in summer when city-main pressure is lower and water temperature higher. Installation in photo does a fine job for us.

Pump has a V-belt drive. Suction pressure from city main is 24 psi, discharge pressure 70 psi, with the regulator set for 38 psi. Regulator keeps pressure within a fraction of a pound of the desired value.

R E FONTAINE *Kenmore, N. Y.*

EDITOR'S NOTE. We were swamped with answers to *DN's* problem and don't have space to publish all. Also, a large number contain similar suggestions, all of which are covered in one way or another in the preceding answers and in some on p 156.

After the following good answer, we list 14 readers who sent it. There are three other such reader lists, p 156.

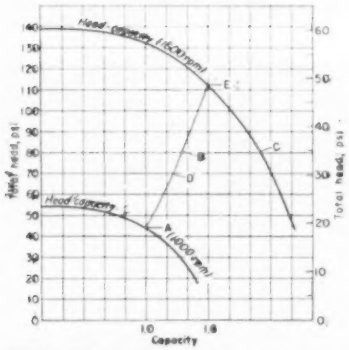
REGULATE PRESSURE with a valve on the discharge side of the pump. Adjust valve to give the desired process pressure.

A W LOVITT *S. Burnaby, B.C.*
H T LIVINGSTON *Los Angeles, Calif.*
G F CONNELL *Berkley, Mich.*
FRANK BUTLER *Dallas, Texas*
H S BRUNSON *St. Paul, Minn.*
A R ECKERT *Mt. Vernon, Ill.*
A M LEADER *Warwick, R. I.*
J R HAUGAN *Chicago, Ill.*
L M MARTINEZ *Rego Park, N. Y.*
EDWARD DELNICK *Valley Stream, N. Y.*
D L COCHRANE *Milaca, Minn.*
ELBERT STOTT *Saundersville, Mass.*
C G HOWARTER *East Peoria, Ill.*
ERNEST SIDEWITZ *Brooklyn, N.Y.*

(*Continued on page* 156)

More PLANT PROBLEMS

Begins on page 154



PUMP RUNS with a slight positive suction head. Little friction appears to be involved on the discharge side of the pump. I also believe that the given pump discharge pressures closely approximate the total head of pump.

In most process units using water, the liquid goes through nozzles or heat exchangers. For these units the head varies as the square of the capacity ratio. So with a pressure of 30 psi, quantity needed is 125.7% greater than with 19 psi.

Capacity of a centrifugal pump at a given point on the characteristic varies directly as the speed ratio; head varies as the square of the speed ratio. Thus, a pump producing a given capacity at 19 psi (43.9-ft total head) at 1000 rpm will develop 30 psi (69.3-ft head) at 1257 rpm.

Curve shows an assumed characteristic for the pump at 1000 rpm with 43.9-ft (19 psi) unit capacity, point *A*. With 69.3 ft (30 psi), point *D*, a capacity demand of 1.257 is to be expected.

Now a more important question arises. Why was only 35 psi obtained at 1600 rpm? If suction conditions were adequate, the pump should have 1.6 more capacity than at 1000 rpm. Head should be 48.6 psi (112.3 ft), point *E*. *DN* says only 35 psi was obtained, at which we would expect a capacity of 1.355, point *B*, assuming head varies as capacity ratio squared. At 1600 rpm and a head of 80.8 ft (35 psi), a much larger capacity, point *C*, would be expected. The only system head curve that could pass through *A* and *C* would be one for a system having considerable static head. This does not appear to be true of *DN*'s layout.

With only meager data, we can but guess at two possible causes. First is that suction-tank outlet is not adequately submerged and air enters pump suction at increased capacity. Second possible cause is that pump has a fairly high specific speed and requires more suction head than actually available if it is to reproduce its normal characteristics at the higher speed. If this is so, pump will cavitate at 1600 rpm and head-capacity obtained will depend on available net suction head and pump design. Characteristic might pass through point *B*.

DN's best solution for this problem is bound to come from the pump manufacturer. Make a complete sketch of the system, giving all data on pipe sizes, fittings and run lengths. Tabulate capacity demand of the process units and give other important data relating to the pump. Show at which point the 30-31 psi is wanted, water-level variations in process tanks, and how demand fluctuates.

Take pressure readings at suction and discharge flanges of the pump while the unit runs. Also measure pump speed and electrical input. Send all this information, together with pump serial number, to the manufacturer. Ask that builder advise what speeds pump should run at for maximum and minimum capacities *if suitable to operate at these conditions with suction head available.*

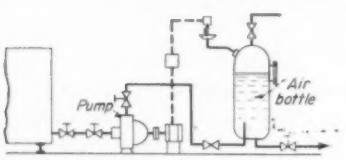
If pump is suitable, manufacturer will give power and speeds required, and *DN* can get a motor with field rheostat control so speed can be adjusted for desired pressure at any capacity demand.

With variable capacity demand, and need to keep within a narrow pressure range, adjustable speed is generally necessary to obtain such close regulation. Throttling is possible if unit is always under control of an operator and is driven by a constant-speed motor. There are a number of other setups.

ROY CARTER
Worthington Corp, Harrison, N. J.

CHANGE IMPELLER or its diameter to obtain the desired output. Consult pump manufacturer before making a change of this sort.

K W HALLENBECK *Long Beach, Calif.*
W H BRITT *Minetto, N. Y.*
J F CRAIG, JR *New York, N. Y.*
D B MACPHERSON *Spokane, Wash.*
E C COLE *Caracas, Venezuela*

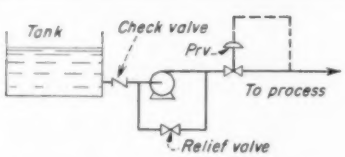


USE AN AIR BOTTLE, as in sketch. This bottle should allow some water-level variation without affecting pressure in the line to process equipment. Adjust pressure-sensitive switch to start pump when system pressure is 30 psi. Stop it when it is 31 psi.

ENSIQUE MOLINA
Buenos Aires, Argentina

ELEVATED TANK or loop will hold constant pressure on pump discharge. This setup is simple and effective.

R K MITCHELL, JR *Martinsville, Va.*
R H FREYBERG *Pleasantville, N. Y.*
L B VILLARTA *Oroquieta, P.I.*
E A ROBERTS *Carlsbad, N.M.*

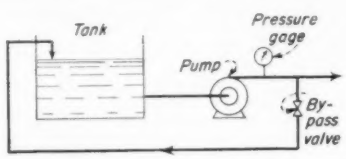


FIRST STEP in solving *DN*'s problem is to increase pump discharge pressure so it can be regulated downward, if necessary. So I suggest he use his 1600-rpm motor to obtain a discharge pressure of 35 psi.

Install a diaphragm-operated prv in the discharge line, as in sketch. Set it for an outlet pressure of 30.5 psi. Then install a relief valve ahead of the prv to bypass water from discharge to suction. Set relief to open at 32 psi, close at 30 psi.

This setup assures positive circulation through pump and permits header pressure to be controlled to demand.

C L MILLER *Paducah, Ky.*



DON'T THROTTLE pump discharge. Use a bypass valve as shown in sketch. Mount a pressure gage close to this valve so operator can see what pump discharge pressure is. Water bypassed returns to supply tank, is not wasted.

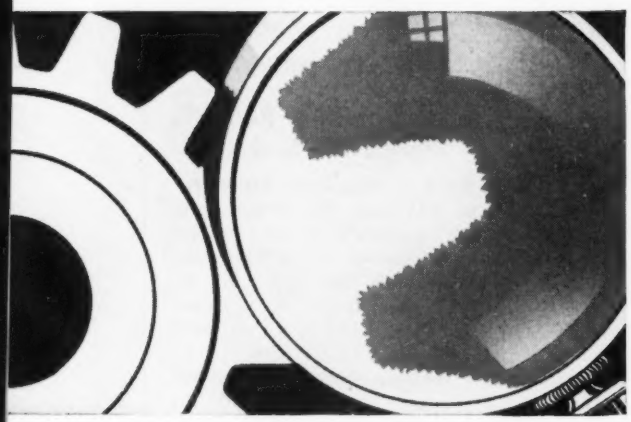
L E POLIKOFF *Brooklyn, N. Y.*

VARIABLE-SPEED DRIVE between pump, motor lets you adjust speed to pressure.

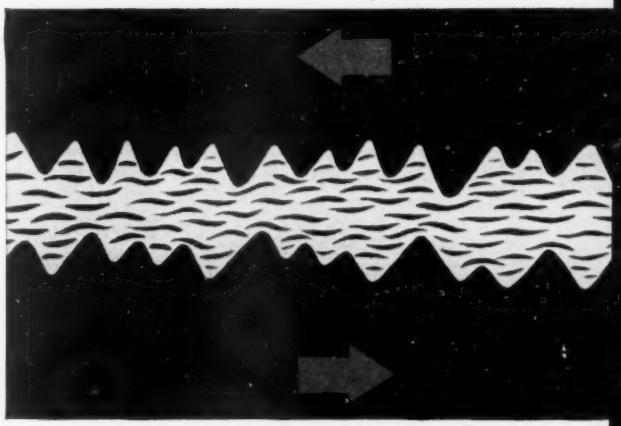
IRA BUTLER *Cincinnati, Ohio*
A M PALMER *Brooklyn, N. Y.*
H A KAISER *Glendale, N. Y.*
H B WAYNE *Brooklyn, N. Y.*
MAXIME CHAUVET V *Mexico*
CHARLES PARKS *Overlea, Md.*

(*Continued on page* 158)

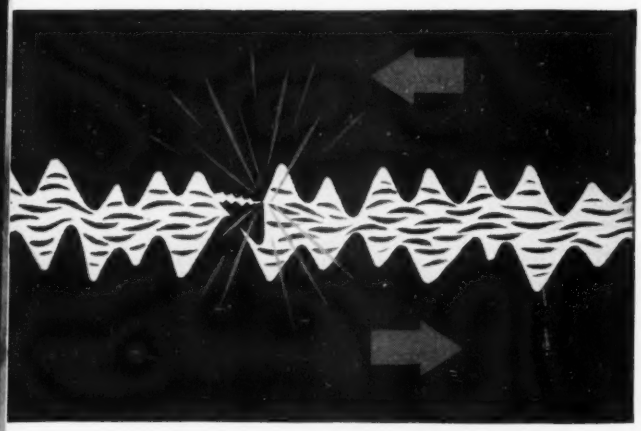
HOW SUNEP PREVENTS GEAR WEAR



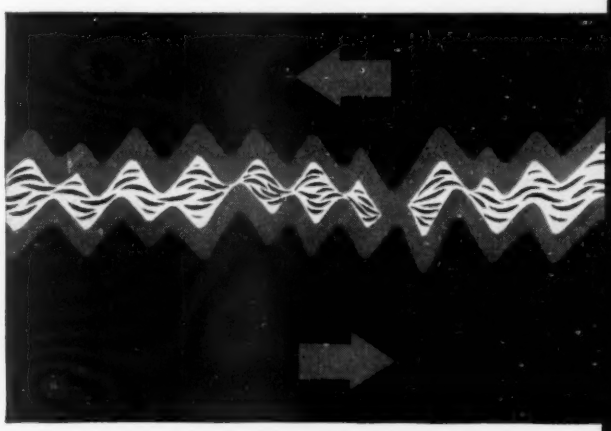
The surface of a gear may seem smooth, but when greatly magnified it looks something like this. The lubricant must keep these jagged edges apart.



With ordinary oil, a thick film is needed to keep these metal surfaces apart. The thickness of the film depends on the viscosity of the oil and other factors.



It is difficult to maintain a thick oil-film in everyday practice. The oil film thins out and semiboundary lubrication results. With ordinary oil, metal to metal contact occurs and gears wear.



Sunep coats the surfaces with a chemically bonded film which is virtually unbreakable. This film, although only about 0.0000001" thick, keeps the surfaces apart, withstands heavy loads and sudden shocks, prevents wear.

Sunep has many advantages. In addition to its outstanding load-carrying ability, it is noncorrosive; it keeps gears and bearings clean; it prevents rusting; it stays put. And its additives do not drop out during use or after prolonged storage. For more information about Sunep and how it protects your equipment, call your nearest Sun office or write SUN OIL COMPANY, Philadelphia 3, Pa., Dept. P-10.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

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More PLANT PROBLEMS

Begins on page 154

How Can We Stop Boiler Vibration?

HERE ARE THE FACTS: We generate steam in four stirling-type chain-grate stoker-fired boilers. Each is rated at 15,000 lb per hr. They have identical arch and furnace construction. One stack and a single breeching serve all units.

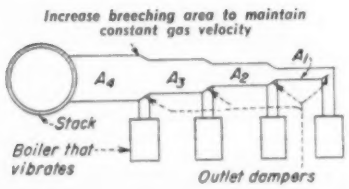
Three of the boilers run well at all times; the fourth often vibrates severely. It is fired with the same fuel as the others, and its stoker receives the same care.

We've checked stack damper for play, baffles for leakage, made CO_2 analyses in each pass, and looked into secondary combustion.

Only way we can stop vibration now is to cut draft entirely, then reopen it slowly, hoping for the best. Boiler may vibrate off and on all day, then stop for weeks.

What's the cause? How can we cure the vibration? What's our best solution for this problem—*HS, July Power*

Here Are 10 Answers



RESTRICTED gas passages cause an increase in gas velocity through the boiler. Since gas quantity varies with steam output, any change in amount of steam generated affects both gas quantity and velocity. When velocity changes, there is a pressure change in the furnace too. This may lead to pulsations or surges in the furnace.

Location of this boiler relative to the others has a bearing on the problem. If this unit is the one closest to the stack, as in sketch, a build-up of gas pressure can occur if breeching area is not large enough to accommodate the gas volume. This is most likely to happen when all boilers are steaming at outputs above their design values.

Increasing breeching area to maintain reasonable velocities is one way of preventing pressure rise. Sketch is only diagrammatic but shows how area can be increased. Either depth or width may be made greater, but application of proper aspect ratio and space limitations dictate which dimension may be increased.

Inspect furnace internally at regular intervals to find if excessive combustion deposits are present. See that gas paths are free and clear. Use steam or air soot blowers if combustion deposits are heavy. Clean tubes also have the advantage of giving higher heat-transfer rates and reduce the possibility of tube failure in the boiler.

H B WAYNE *Brooklyn, N. Y.*

CHECK FURNACE for air leaks. See that fuel-bed depth is right for this stoker type. If *HS* checks both these items, I'm sure he'll be able to cure the trouble he is having.

W E WARNER *Essex, England*

INSUFFICIENT excess air at higher ratings causes boiler vibration. Combustion is incomplete under these conditions. Automatic controls are the best solution.

If grate fingers or clips are mounted too tight on the rails, they do not have enough end play to make them self-cleaning. We use pinhole-type clips on grate rails. These allow free air passage under the fuel bed. Good fuel-bed agitation is obtained with an air pressure of 1½ to 3 in. in the windbox.

Keep stack and breeching in good repair at all times, seeing that they are air-tight and well insulated. If volatile gases receive enough air to insure complete combustion, the vibration should stop.

ART BELTON *Montreal, Can.*

MISALIGNMENT of metal in breeching or stack may cause this trouble. Try closing the dampers on the other three boilers to see what effect this has on the vibration. Don't close dampers fully—a slight amount should be sufficient.

Check all plant equipment that is supported by the same steel beams as No. 4 boiler, or beams near it. See that there are no concave or convex areas in flat breeching and uptakes. Check forced- and induced-draft fans for overloading or wrong speed.

C G HOWARTER *East Peoria, Ill.*

(*Continued on page 236*)

EXCESSIVE gas velocity may be cause. Increase flow areas to reduce gas velocity through the boiler.

A A HUNNEWINKEL *Woodstock, Ill.*

YOUR NEW PROBLEMS

1 What's Best Boiler Operating Method?

We have three 750,000-lb-per-hr 1475-psig 925-F boilers in our industrial plant. Several questions concerning their operation have been bothering us. We'd like the opinions of *Power* readers on any or all of these problems.

What's longest period we can run a boiler without shutting down for inspection and maintenance if unit is in good condition, and there are no local rules requiring annual inspection?

How long a period can elapse between safety-valve tests? Should valves be tested by hand or pressure? Which gives best results, safety-valve repair by manufacturer or by plant maintenance men?

Should handhole caps in round and box headers be reseated and regasketed, or is seal welding better to stop water and steam leaks?

What is best shutdown procedure for units of this type? How should boiler be drained? How much time is needed for warm-up after unit has been shut down?—*EY*

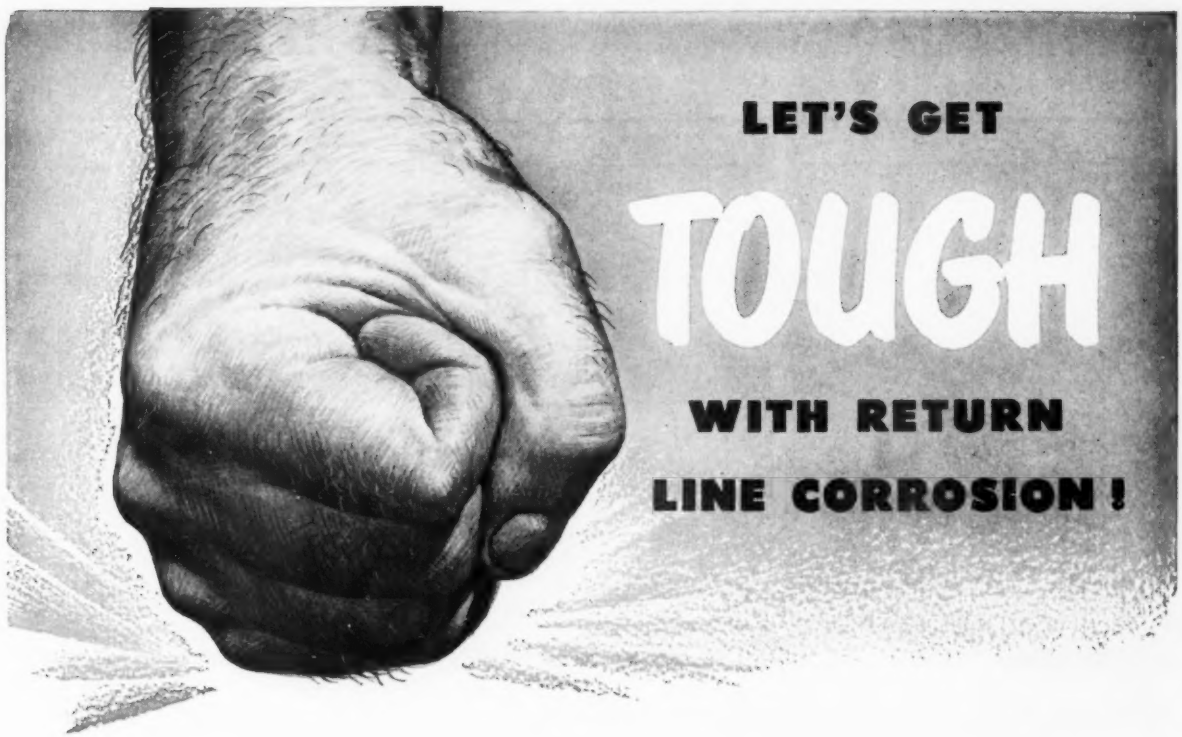
2 How Can We Test Job Applicants?

We need a new assistant engineer in our stoker-fired steam plant. We have several applicants for the job but are at a loss on how to find out what they know.

Is there any questionnaire we can use to test an applicant and find if he is fitted for the job? Though our plant is not large we must have dependable service.

Have any *Power* readers developed a short test, good for job seekers? What is it like? What kind of results does it give?—*PW*

Will you help readers who sent us problems? Extra pay for photos or sketches.



Any way you figure it, corrosion of steam and condensate lines is a serious problem . . . and a costly one! Replacement of corroded lines, interrupted production, increased labor and maintenance send costs spiraling far beyond the limits of economical plant operation. But something can be done about it *right now*, with complete assurance of satisfactory results.

Take the case, for example, of a large plastics molding plant which operated the cycle on its molding machines alternately with steam and oxygen-saturated cooling water. Under these conditions, severe corrosion resulted. Check valves on the steam supply lines to the machines had an average life of only one week—*sometimes even less!* Costs were skyrocketing.

Here's what Betz did about it. By applying its patented filming amine treatment, piping and valve losses stopped *immediately!* After three years' treatment with this advanced technique, satisfactory corrosion control continues. What's more, plant records show savings in labor and maintenance have averaged 30 times the cost of the treatment applied.

This is just one example of how Betz Engineers help keep plants *like yours* at peak operating efficiency. Why not get in touch with Betz today as the first step toward solving your particular water problems. There's no obligation, of course. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: Betz Laboratories Limited, Montreal 1.

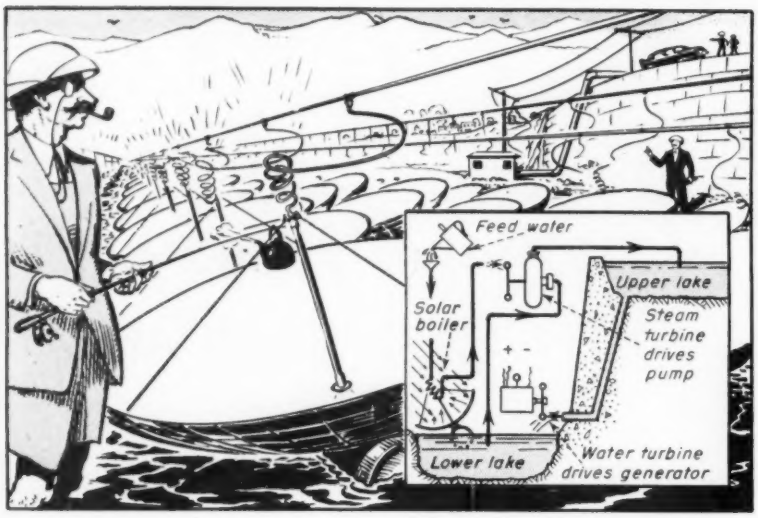
For the full facts and figures on how BETZ is solving return line corrosion problems in plants like yours, write today for Technical Paper No. 124.

BETZ

CONSULTANTS ON ALL WATER PROBLEMS

ARGUMENTS

Here's the place to unload your gripes to editors, manufacturers and fellow engineers



Whoosh! This System Requires Reflection

WHILE DISCUSSING Marmaduke's stories at our tea table, one of my engineer friends said that successful solar cookers had been developed here, in India, and large-scale productions were in progress. We could even electrify small towns with solar energy, he claimed. (Day temperature is 116 F in summer.)

I inquired, "How can you do this?"

He said you should float a lot of parabolic reflectors over the entire surface of a big lake near the town to be electrified. Reflectors should be mounted on barrels and rotated so they always face the sun.

Tubes containing water pass through the focuses of the parabolas. Water passes through these hot spots, gets gradually heated, forming a large quantity of low-pressure steam that drives several low-pressure turbines.

The turbines run high-lift pumps, taking water from the original lake to an artificial lake at a higher level. Water thus stored in the higher lake during the daytime of, say, eight hours flows through pipes to a water turbine. Finally, it discharges into the lake it was taken from.

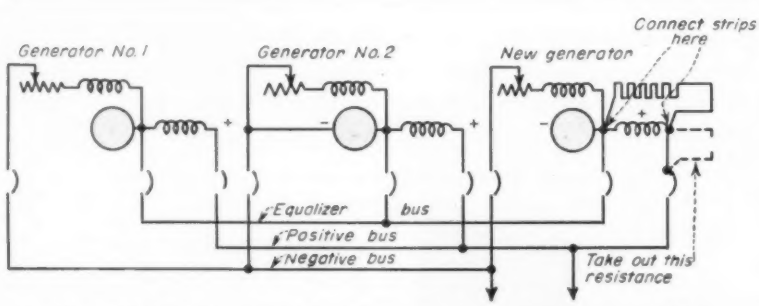
The water turbine, in turn, drives an electric generator 24 hours a day. Electricity thus obtained is used for small industries, pumps, lights, fans, etc.

At this point someone remarked that the solar reflectors could be dispensed with if we used part of the electricity to drive electric motors, which, in turn, would drive the pumps that lift water from the lower to the higher lake.

Now we're stumped. Will you kindly ask Marmaduke Surfaceblow, the consulting engineer, whether this is possible? It's just what we have wanted for a long time.

R K MUKHERJEE
West Bengal, India

EDITOR'S NOTE: *On hearing this proposal, Marmaduke roared, "Bilgewater on barrel-mounted solar generators! Those engineers in India may be able to fool the* POWER *editors, but they can't kid me."*



Tin Strip Corrects Generator Compounding

I HAVE HAD the trouble described in "Paralleling Compound Generators" (June POWER). I correct it in a simpler way that does not put any resistance in armature circuit. Here's my system:

Wrap a strip of sheet tin, 2 in. wide by 24 in. long, with muslin or friction tape, leaving the ends bare for 3 in. Shape into accordion pleats to make it compact. Then notch ends to fit under the bolt connections of over-compounded generator's series winding, see sketch. In this case, new generator is over-compounded. If one strip doesn't do the job, add another the same way. After a few trials, you will arrive at a balance, and the generators will divide the load correctly.

It is good practice, especially on generators in service a long time, to go over the series field connections, clean the contacts, and double-check to be sure series coil connections are fast.

W VONBENKEN *Cleveland, Ohio*

Orchids for POWER

Your work has been of inestimable value to the thousands of us in the field, who, without benefit of either clergy or college, can learn only when things are broken down to our size, that is, understandable English.

As one of my engineers expressed himself, after trying for hours to extract a bit of information from one of the "learned" engineering books, "I swear t'God, only an Epstein could make sense out of this junk."

L J BORRESON *Minneapolis, Minn.*

Sign Your Name

The highly interesting letter we received from "Old-Timer," Chicago, Ill., will have to die in "Arguments" files unless "Old-Timer" lets us know his real name and full address. It's POWER *policy, not discrimination. We can't print anonymous letters.*

If any contributor prefers to use a pen name, we'll abide by his wishes and keep his name confidential. But we need complete names and addresses for our private files.—EDITOR.

FOR BIG CONDENSATE LOADS...

from Purifiers, Separators, Water Heaters, Flash Tanks, Desuperheaters, Heat Exchangers, Evaporators, Vacuum Pans, Continuous Blow Down Systems

...it pays to use ARMSTRONG COMPOUND STEAM TRAPS!

Because:

1. **They provide automatic drainage of condensate** or boiler carryover loads too big for ordinary traps to handle (up to 300,000 lbs/hr).
2. **They are relatively small size**—the No. 237 compound trap is only twice the height and size of the largest Armstrong standard trap, yet has many times the capacity.
3. **There are cast or forged models for any pressure up to 600 lbs.**
4. **They are simple, dependable and trouble-free**—the inverted bucket pilot mechanism is the same as the mechanism in standard Armstrong traps, proven in thousands of installations. This mechanism plus a simple piston and large main valve is all there is to it. All parts are made of special wear-and-corrosion resistant steels.
5. **They are easy to install.**
6. **They can be completely overhauled without removing from the line.**
7. **They are moderately priced.**
8. **They are guaranteed to give complete satisfaction.**

Your local Armstrong Representative is fully qualified to answer your questions about these traps and their use. Give him a call, or write:

ARMSTRONG MACHINE WORKS
812 Maple St., Three Rivers, Michigan

Armstrong cast semi-steel compound trap draining coils of large storage type hot water heater.

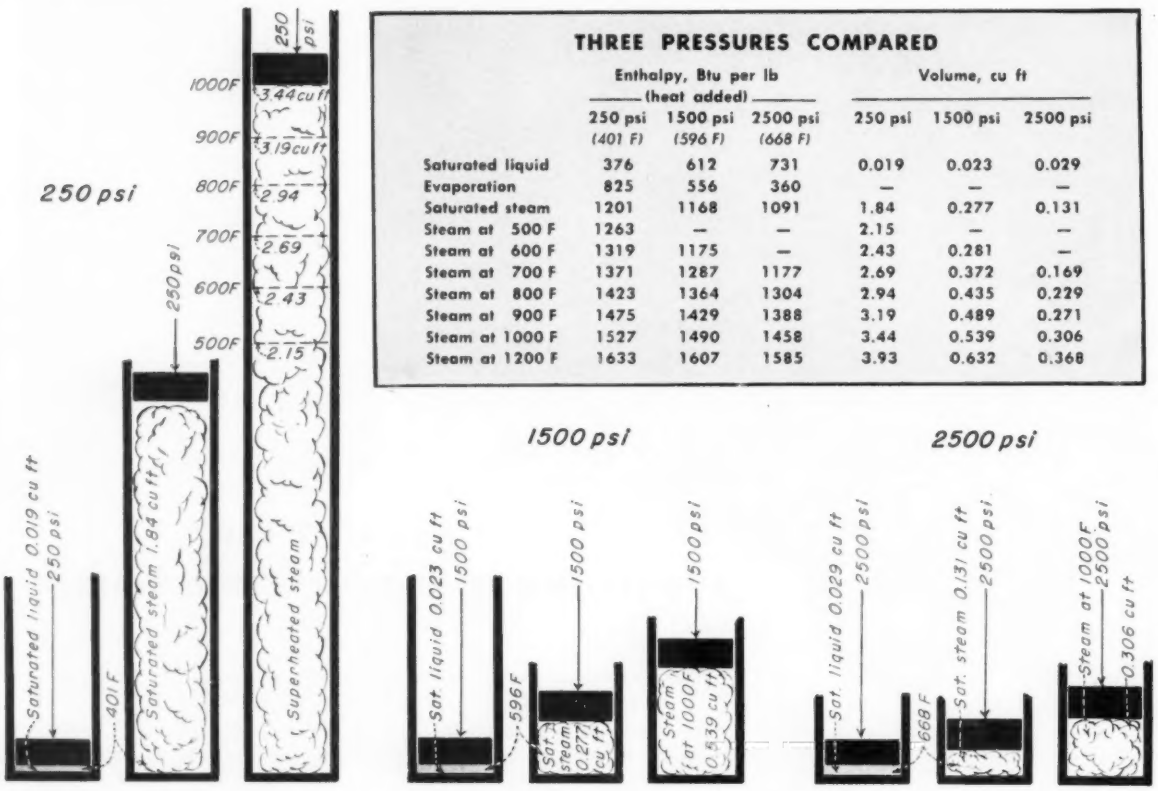
SEND FOR NEW BULLETIN

For complete information ask for 8-page bulletin, No. 215 . . . explains and illustrates operation and installation of Armstrong Compound Traps; includes physical data and list prices. Free on request—no obligation.

ARMSTRONG STEAM TRAPS

HEADWORK

PHIL SWAIN BRINGS ENGINEERING THEORY DOWN TO EARTH



THREE PRESSURES COMPARED

	Enthalpy, Btu per lb (heat added)			Volume, cu ft		
	250 psi (401 F)	1500 psi (596 F)	2500 psi (668 F)	250 psi	1500 psi	2500 psi
Saturated liquid	376	612	731	0.019	0.023	0.029
Evaporation	825	556	360	—	—	—
Saturated steam	1201	1168	1091	1.84	0.277	0.131
Steam at 500 F	1263	—	—	2.15	—	—
Steam at 600 F	1319	1175	—	2.43	0.281	—
Steam at 700 F	1371	1287	1177	2.69	0.372	0.169
Steam at 800 F	1423	1364	1304	2.94	0.435	0.229
Steam at 900 F	1475	1429	1388	3.19	0.489	0.271
Steam at 1000 F	1527	1490	1458	3.44	0.539	0.306
Steam at 1200 F	1633	1607	1585	3.93	0.632	0.368

The ABC of Superpressure—1

► NOW THAT PLANS have been announced for a boiler to deliver steam at 4500 psi (4500 lb sq in.), power engineers will want to understand the reason for such superpressures.

This new series will explain, in plain English, what happens when you generate and use steam above the "critical pressure" of 3206 psi. Beyond that point you can make steam without "boiling," so boilers will not need any drums.

More about that later. First, let's see what happens when you generate steam at today's pressures of 250 psi, 1500 psi and 2500 psi.

For each pressure (absolute) the sketches and table show the volume of one pound of saturated liquid (that is, water at boiling temperature), one pound of saturated steam (steam at the boiling temperature) and one pound of superheated steam at various temperatures up to 1200 F.

See what a big difference pressure makes in steam volume. The table shows that raising the pressure of saturated steam from 250 psi to 2500 psi cuts its volume far more than 90%.

Left side of the table shows how much heat must be added to warm the water from 32 F up to the boiling point, then evaporate it and finally superheat it. Using the modern terminology, heat *added* is called *enthalpy*—of saturated liquid, of evaporation, and of superheat.

Total enthalpy at any stage is the sum of the parts. For example, at 1500 psi, it takes 612 Btu to heat water from 32 F to the boiling point of 596 F. It takes another 556 Btu to evaporate it. This gives 1168 Btu (612 + 556) as the enthalpy of the saturated steam. Total enthalpy of superheated steam at 1000 F is 1490 Btu.

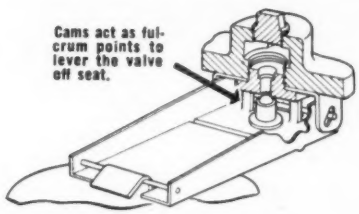
Does it take more heat to make high-pressure steam? Actually, it takes slighty *less* to convert one pound of ice water at 32 F into 1000-F steam at the higher pressure—takes 1527 Btu at 250 psi, and only 1458 Btu at 2500 psi.

Next month, we'll see what happens at critical pressure.

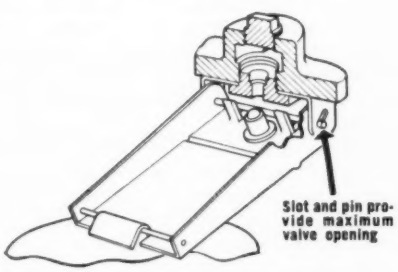
See how this ***NEW*** *trap handles greater volume in less time*

Yet it's small—gives you maximum capacity per dollar cost

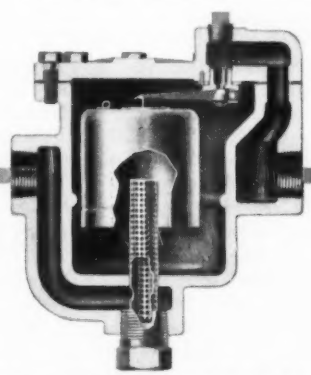
NEW SARCO
INVERTED BUCKET TRAP
with CAMLIFT valve mechanism

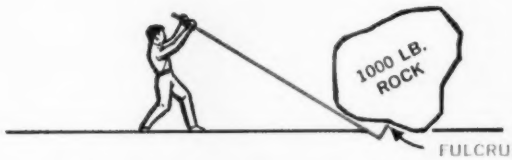


As bucket sinks CAMLIFT mechanism provides the powerful crowbar action needed to open large valve against steam pressure.

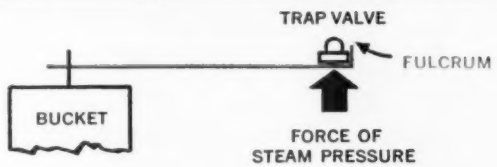


When steam pressure is overcome CAMLIFT mechanism drops to limit of slot, allowing rapid and free discharge of condensate.





MAN WITH CROWBAR MOVES 5 TIMES HIS WEIGHT



TRAP WITH *CAMLIFT* MECHANISM OPENS LARGE VALVE AGAINST MAXIMUM OPERATING PRESSURES

SARCO takes the principle of the fulcrum, incorporates it in its newly designed trap and gives you greater discharge with *no increase in trap size*. That means you get more for your steam trap dollar.

The Sarco *Camlift* valve mechanism makes this possible. It provides the powerful force needed to open the unusually large valve without a corresponding increase in trap size.

If you need a trap that's also rugged and simple in design, then we suggest you try this new Sarco Inverted Bucket Trap – in fact, we'd like to send you one for a free trial. We're confident you'll be convinced. Just clip the coupon and mail it in.

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Sarco Canada Ltd., Toronto 8, Ont.
Represented in Principal Cities

MAIL THIS COUPON TODAY FOR FREE TRIAL

Put this new inverted bucket trap to the test—see for yourself how to get more for your trap dollar.

Sarco Company, Inc., Empire State Bldg., New York 1, N.Y.

Gentlemen: Please send me a ½" Sarco Type B Bucket Trap for free trial. Maximum working pressure_____ psi; capacity_____ lbs/hr condensate.

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

CITY_____ STATE_____

STEAM TRAPS • TEMPERATURE CONTROLS • STRAINERS • HEATING SPECIALTIES

"Gentlemen, this is Mr Surfaceblow, the best chief engineer I ever sailed with."

The Governor Goes Hunting

► A LETTER FROM JAMES WHYTE of Lynwood, California, brought back some interesting memories of our World War II experiences aboard ship. In my own case I was aboard an AKA (attack cargo amphibious), while Jim writes about a Navy tanker.

Because of the great activity in ship yards, green personnel and demand for new ships, life was a little on the hectic side down below in the engine room.

"Maybe this letter will cause Marmaduke Surfaceblow to sound off about someting," I thought after reading Whyte's interesting note. So I put on my coat and headed for the old consulting engineers office above O'Houlihan's Machine Shop & Engine Works.

Marmy was wading through a manufacturer's catalog when I barged in. His desk was stacked with literature and it looked like he was doing some real masterminding. There were electrical blue prints all over the place.

"Here's an incident that took place aboard a Navy tanker in the last war," I said quietly, not wanting to break into the old boy's high-pressure thinking too suddenly.

Marmaduke looked up from his work and barked, "BILGEWATER ON NAVY TANKERS! I'll tell you about a turbine governor that had everybody hunting—including me."

With that Marmy leaned back in his swivel chair, hoisted his size 16 canal boats up on his old desk, lit a rope yarn and started puffing furiously. Then he characteristically stuck his huge thumbs into the armpits of his checkered vest and blasted away.

"Back in the winter of 1937 I walked off the freighter *SS Orizoba* when she pulled into San Francisco. The maritime strike was in full swing and ships were struck soon as they arrived in port.

"After dropping anchor in a rooming house off the Embarcadaro, I looked up my old shipmate Jim Gillispi who had taken over the chief's job in a sugar mill across the bay near Oakland. Next morning I visited his plant and I could see that Jim was having his troubles.

"The place was filled with big shots, all running around in circles. And I could see that this madhouse was caused by one of the turbo-generator sets. It kept racing and slowing down while the governor was on a wild hunting spree. Then the overspeed trip would stop her. Started again, she would go through the same crazy antics, whining like a four-alarm fire sireen. And those meters swinging back and forth on the instrument board made your head spin like a propeller.

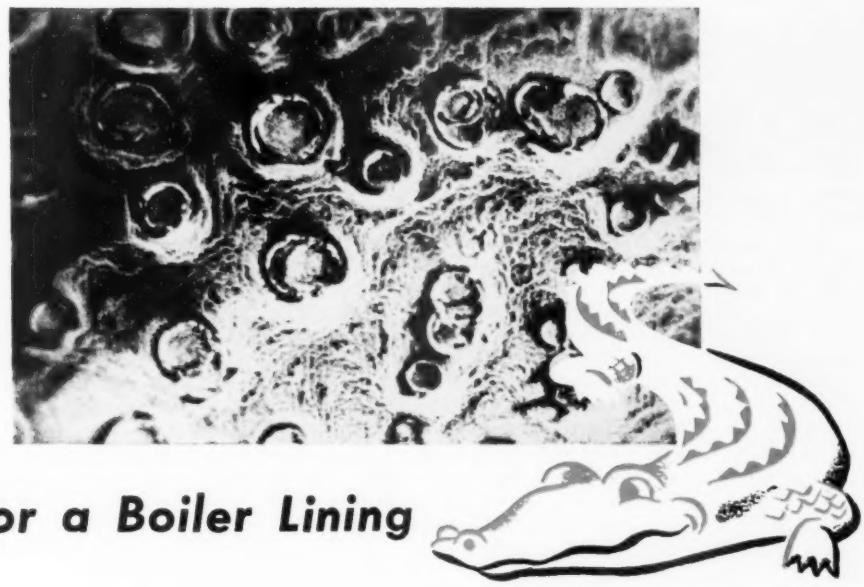
"This was better than a circus sideshow, so I sat down on an empty packing case and took it all in quietly. Later I learned the steam turbines and electrical equipment had gone through a major overhaul a few weeks before and something had gone haywire—but good.

"There were three turbo-generators of 500 kva at 480 volts, 3 phase. The turbines, generators and exciters had all been torn down by an outside firm and were supposed to be put into first class condition. The contract called for a design test run of two hours at full load, a half hour at 120 per cent load each, then parallel operation of all three and any combination of two. That meant three generators to be operated singly in parallel of two, or all three on the line at once.

"Numbers 1 and 3 were ready first. They passed their test with flying colors, after only a few minor adjustments. But when No. 2 was put on for

(*Continued on page* 238)

Alligator Hide



for a Boiler Lining

THIS unusual form of calcium carbonate sludge could cause more trouble inside your boilers than a live alligator in the control room. That is why Nalco scientists deliberately cause scale and corrosion conditions in test boilers, then find the water treatment solutions for them — without subjecting Nalco System users to a "guinea-pig" role in testing new chemicals.

If your plant is not already enjoying the security of The Nalco System, ask for a water treatment survey, now. It may be the means of saving you real money on water treatment chemicals and plant maintenance.

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"This is Nalco"

A 28-page, full-color trip through Nalco laboratories and plants—designed to be next best to a visit in person to the outstanding facilities and personnel Nalco puts at your disposal. Your copy sent free upon request. Write for it today.

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THE *Nalco* **SYSTEM . . . Serving Industry through Practical Applied Science**

JENKINS PRACTICAL PIPING LAYOUTS

70

How to plan an

INDUSTRIAL WASTE TREATMENT SYSTEM

The rising costs and difficulties of providing satisfactory water supplies have made municipalities, state governments and industry increasingly aware of the need for conserving present sources. In an effort to eliminate or reduce pollution of waters by sewage or industrial wastes, many states and municipalities have drawn up stringent codes regulating the types of waste which may be discharged into streams and rivers.

Waste can be treated by either chemical, physical or biological means, depending on its nature. The simplest treatment is the physical, which involves screening, filtration, and gravity separation. This method is particularly effective on wastes containing suspended solids. The customary treatment for human sewage is biological, to allow the formation of stable organic compounds through the action of bacteria. A great deal of chemical waste resulting from industrial processes responds most readily to chemical treatment.

Neutralization of acid waste is one of the most common problems encountered in the treatment of industrial discharges. When such waste flows untreated into a stream, it destroys organic life and leads to the abandonment of the stream as a source of water supply.

Lime is used for neutralization of acid waste in the system shown. While other chemicals are available, lime is usually the cheapest and most satisfactory neutralizing agent. The waste normally flows to a digester which allows for settlement of solids and serves as a storage center from which flow to the treatment tank is regulated by a liquid level controller.

The treatment tank is equipped with an agitator which mixes the waste with the lime slurry to provide a neutral solution. In treating certain types of waste, precipitation of a solid may occur. This can be removed at intervals, for possible industrial use, in the plant or elsewhere, or for disposal. The effluent is decanted off the top of the treatment tank.

The proportion of lime to be added is determined by a recording pH regulator, which operates the control valve on the slurry line. It is responsive to the pH of the waste and admits the required amount of slurry for neutralization.

The slurry is made by admitting quicklime and water, regulated by a liquid level controller, to the lime slurry mixer, which is equipped with an agitator. Emergency lines for direct discharge bypassing the treatment system are indicated in the diagram.

Bronze valves are used on the fresh water supply lines and all iron valves on the lime slurry lines and waste lines in this system. The Fig. 40-A recommended for the lime slurry tank drain is the popular Jenkins U-Bolt Gate. The simple, rugged construction of this valve makes it a practical design for punishing service, especially where sediment is a problem. It is easy to clean, and the removable "Bonnet-Saver Bushing" can be quickly and economically replaced, when worn, to restore new-like operating efficiency. It is available with Iron Body, Bronze Mounted (as Fig. 42-A) as well as All Iron.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation.

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the complete Jenkins line. It's your best assurance of lowest cost in the long run. Jenkins Bros., 100 Park Ave., New York 17. Sold through leading Industrial Distributors everywhere.

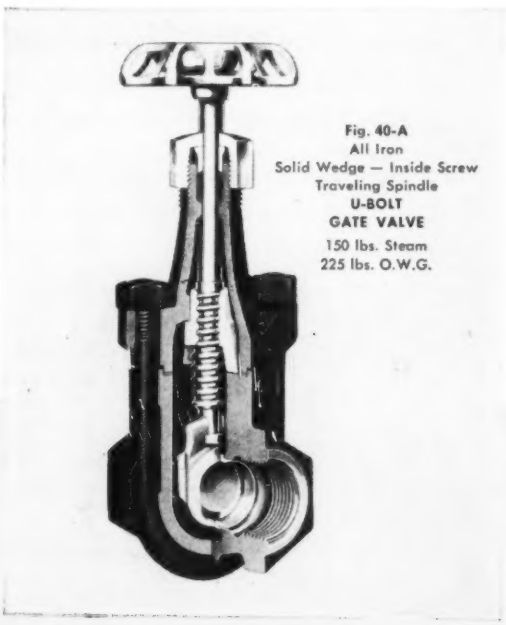

Fig. 40-A
All Iron
Solid Wedge — Inside Screw
Traveling Spindle
U-BOLT
GATE VALVE
150 lbs. Steam
225 lbs. O.W.G.

SEND FOR THIS FOLDER. It illustrates and describes the unique construction features of Jenkins U-Bolt Gate Valves, and gives complete dimensions. Fill out and mail the coupon today.

JENKINS BROS., 100 Park Ave.
New York 17, N. Y.

Please send folder on U-Bolt Gates

Name .....

Company .....

Address .....

INDUSTRIAL WASTE TREATMENT SYSTEM

Illustrating the proved 3-point formula for trouble-free, time-defying hookups

A Use the right type valve for the service

B Place valves correctly in the line

C Choose Jenkins for lifetime economy

JENKINS VALVES

LOOK FOR THE DIAMOND MARK

SINCE 1864 TRADE JENKINS MARK

Jenkins Bros

VALVE RECOMMENDATIONS

For details of valves to suit varying conditions, see Jenkins Catalog.

Code	Quan.	Fig. No.	Jenkins Valve	Service
A	2	62-U	Bronze Gate	Shut off Float Control Water Supply
B	1	106-A	Bronze Globe	Float Control Manual By-Pass Water Supply
C	2	100	All Iron Gate	Shut off Control Lime Slurry Feed
D	1	81	All Iron Globe	Manual Control By-Pass Lime Slurry Feed
E	2	100	All Iron Gate	Shut off Float Control Treatment Tank Feed
F	1	81	All Iron Globe	Control Manual By-Pass Treatment Tank Feed
G	1	100	All Iron Gate	Effluent Discharge
H	1	40-A	All Iron Gate	Lime Slurry Supply Tank Drain
J	1	81	All Iron Gate	Treatment Tank Drain
K	4	100	All Iron Gate	Emergency Waste Discharge
L	4	100	All Iron Gate	Shut off Waste Lines
M	1	81	All Iron Globe	Digester drain

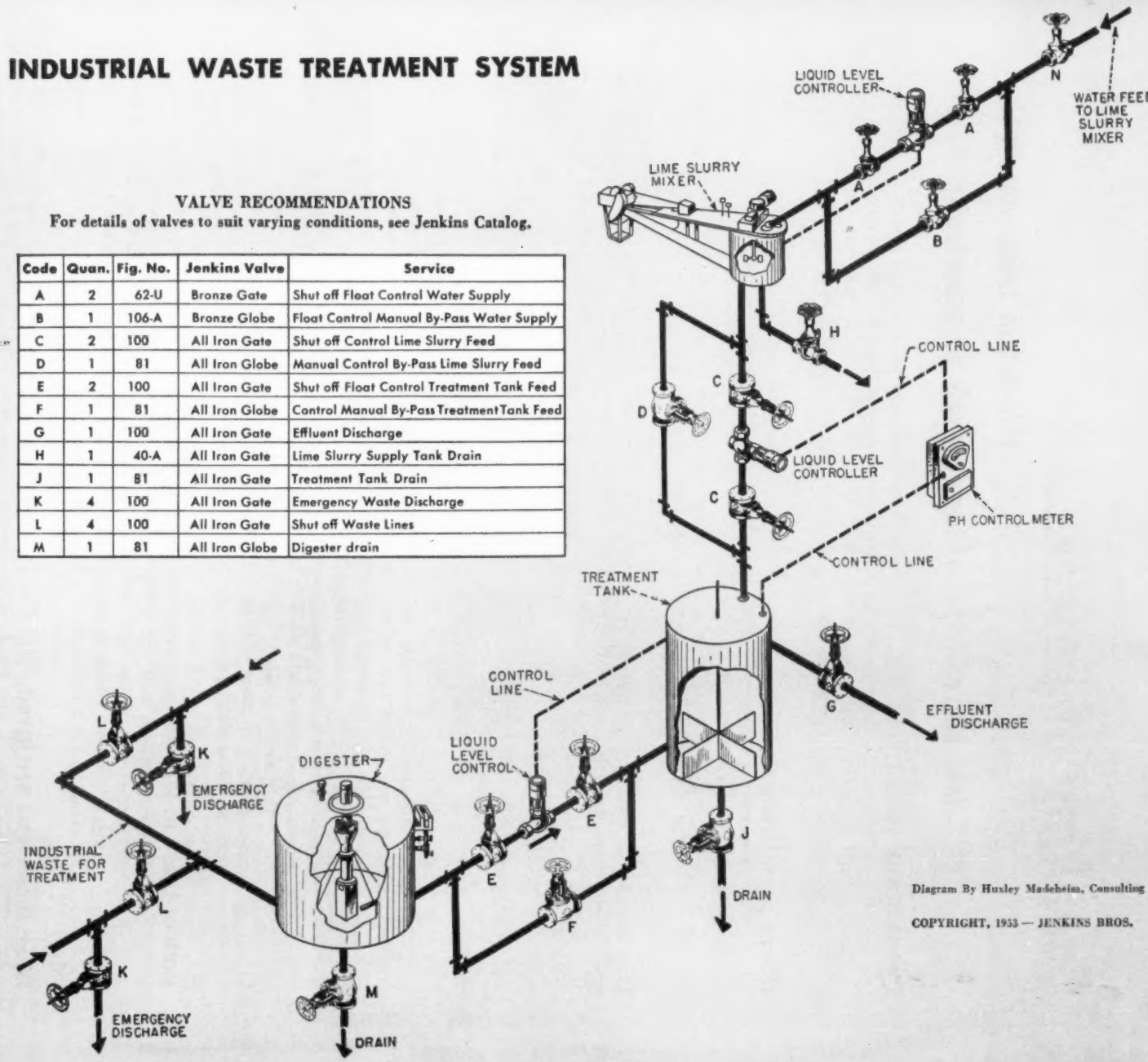

Diagram By Huxley Madeheim, Consulting Engineer

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Speaking of power...

this month takes you right into our editorial offices, reveals an opportunity there

Two men are wanted to help Power build for the future. They will come to us as assistant editors. How far they will go thereafter will be up to them. We can promise full cooperation and a unique opportunity to do creative engineering work as members of an editorial team devoted to the best in technical publishing.

It's no great trick to find editors, even engineering editors – but finding the right men is vastly tougher. We'll have the best chance of making a perfect match of man and job if we start with the broadest base for selection. That's why we are now letting the power world know of opportunities that will automatically interest the kind of men who could make good on these jobs.

One assistant editor will come to us primarily as a power engineer rather than a journalist. He is now actively engaged in power work. He is particularly at home in a steam plant, probably an industrial steam plant. He has a good fundamental and practical understanding of several power services – say refrigeration, air conditioning, compressed air. Chances are he never worked on any publication, but has some understanding of the art of clear writing – and can learn. You might call him a potential engineer-journalist with a strong accent on engineer.

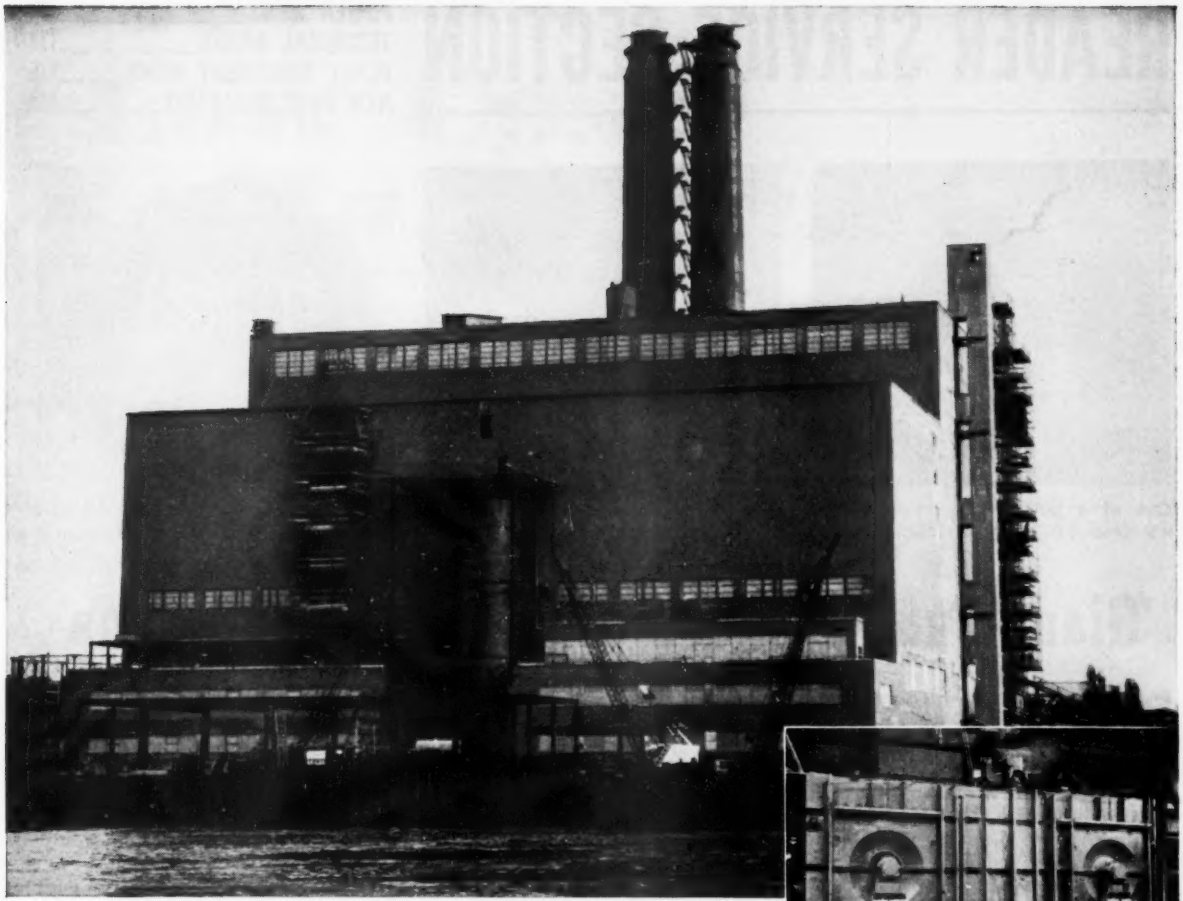
For the other editor, the accent is reversed. He may, or may not, be a full-fledged engineer. But he is highly skilled and experienced in the arts of writing, rewriting and article organization. He knows how to apply these abilities to material originally assembled by technical editors, how to put these facts across by skillful use of words, photographs and drawings. Very likely he has some special interest in engineering science and mechanics and hence can do a particularly good journalistic job with technical material.

This man is primarily a journalist, able to blend his skills with the technical knowhow of other staffmen for interesting, fast-moving and clear presentation of engineering, operating and maintenance ideas.

Both of these prospects are mature men, but fairly young in years – say 25 to 40. Both have energy, initiative and judgment. Both have ability to meet and work with power men in the field and with their fellow editors. Headquarters are Power's New York office. Salary is open – it will depend on each man's particular background and abilities.

When these men are hired, they'll enter a new life of exciting and creative work. Working closely with Power's experienced editors, they'll have unbounded opportunity to learn how a skilled technical journalist staff gathers significant engineering information, organizes it for maximum usefulness and presents it in clear, easy-to-grasp style. From a front seat, they'll watch (and play a part in) the parade of industrial progress. In the process of transmitting engineering ideas, they'll grow in personal technical knowledge and understanding. Most important of all, they'll find no limits on creativeness and accomplishment because Power recognizes no such limitations. That's why Power continues a 70-year record of growth and why these men will grow with it.

Address



Astoria's 1,200,000 lb. boilers are among the world's largest. Sturtevant fans furnish 600,000 CFM forced draft on each.

NEW AIRFOIL FANS

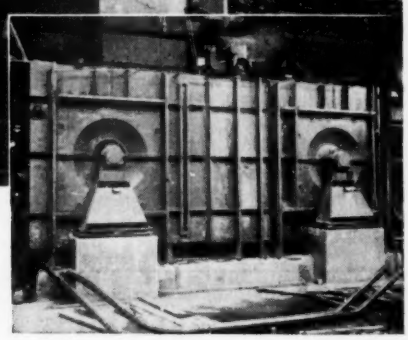
GIVE GREATEST ECONOMY AT ASTORIA

Pressurized boilers at Consolidated Edison's Astoria Station are designed to operate without induced draft. In a fan arrangement never before used by a public utility, eight new Sturtevant Airfoil-Bladed Fans are connected in series of two for forced draft.

Each tandem is rated for 300,000 CFM at 38" pressure. At part loads, only one fan of each pair is used. Thus the fans operate at or near peak efficiency at all times.

Airfoil-Bladed Fans retain the self-limiting horsepower characteristics and reach peak efficiencies of *over 90%*. They are designed primarily for application where low operating cost and quiet operation mean more than first cost.

For full information on the Airfoil-Bladed Centrifugal Fan, ask for new Catalog 1320. Call your Westinghouse-Sturtevant office. Westinghouse Electric Corp., Sturtevant Division, Hyde Park 36, Mass.



The "boxcar" being installed above houses two Airfoil Fans in tandem. Two units totaling four fans serve each boiler. A unique by-pass system permits operation of any two fans in each four-fan unit. All fans are equipped with power-saving Vane Control® to permit instantaneous control of output.

WESTINGHOUSE AIR HANDLING

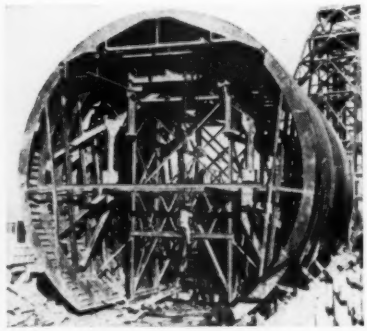
YOU CAN BE SURE...IF IT'S Westinghouse

READER SERVICE SECTION

POWER NEWS 170
TECHNICAL BRIEFS 172
PLANT EQUIPMENT NEWS 176
NEW FREE BULLETINS 185

One of a pair of giant tunnels that will feed $300-million Niagara station

Unlined tunnel has 51-ft dia, lining requires one million cu yd of concrete



Steel forms for 3-ft concrete lining were built by Blaw-Knox Co of Pittsburgh

Giant Tunnels Feed Niagara Power Station

► TWO GIANT TUNNELS will divert water from Niagara Falls to the new $300-million electric power station being erected in Canada.

The water will be taken from the Upper Niagara River, near Chippawa, two miles above the Falls. Twin tunnels will carry it under the city of Niagara Falls, Ontario and take it to a point below the Falls for a total journey of 5½ miles. At this point, the tunnels will tie in with a 2¼-mile surface canal that will deliver the combined supply to the Sir Adam Beck Generating Station.

Actual site of the power plant is on the side of a 300-ft cliff of the Lower Niagara River Gorge six miles below the Falls. This station will have a generating capacity of 1.2-million kw—enough for the residential needs of 7 to 8-million people. Four of its 12 generating units are expected to be running next year; the remainder will reach full operation by 1957.

Some idea of the scope of the tunnel construction can be seen in the above photos that were provided through the courtesy of Ontario's Hydroelectric Power Commission.

Among the largest in the world, these tunnels have a rough diameter of 51 ft.

(*Continued on page* 254)

New Plant Builds Key Turbine Parts

SMITH-KAPLAN RUNNER. One of the adjustable blade runners, 23 ft 7 in. in dia, for the 14 McNary Dam turbines, each 111,300 hp at 87.5 rpm and 80-ft head

► S MORGAN SMITH CO, one of the largest manufacturers of hydraulic turbines and associated equipment, recently opened its new $3-million plant at York, Pa.

The new plant has two bays, each 90 ft wide by 400 and 600 ft long respectively. In addition, it has a 42-ft boring mill, cranes of 25 to 100-ton capacity and a variety of large welding apparatus and machine tools. With these new facilities, the company expects to work off a backlog of orders that totaled about $50-million at the close of the war.

As part of plant opening ceremonies, the company exhibited key turbine units that it is currently manufacturing for the Corps of Engineers' McNary Dam plant on the Columbia River. Photo at left shows the adjustable-blade runner for one of 14 turbines that will comprise the initial installation. This number will later be increased to 20 for an ultimate capacity of 2,226,000 hp.

These are the highest powered Smith-Kaplan turbines in the world. Each of the six runner blades weighs 30,000 lb and a complete turbine unit weighs 1000 tons when completely installed.

For coming events see page 256

Dr Adolph Meyer

Adolph Meyer Receives G R Henderson Medal

► DR. ADOLPH MEYER will receive the George R Henderson Medal from Franklin Institute of Pennsylvania for his accomplishments in the gas turbine field. The award will be part of the annual Medal Day Ceremonies to be held in

(*Continued on page* 256)

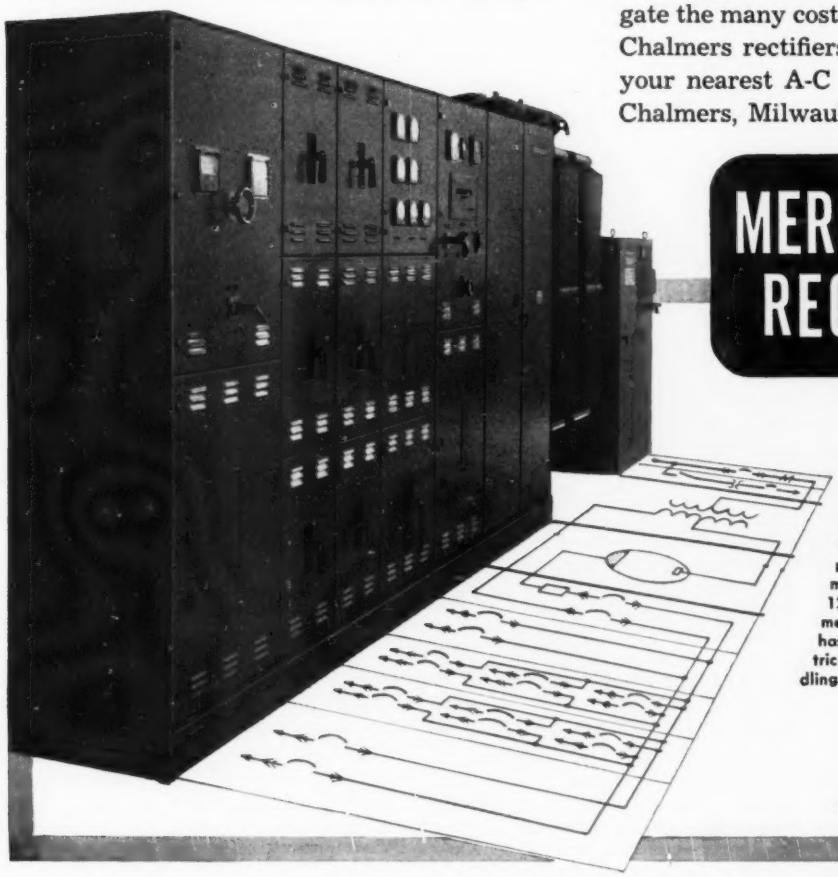
Low Cost *Installation*

FACTORY PACKAGED RECTIFIER UNITS CUT INSTALLATION TIME AND COSTS

The factory packaged design of Allis-Chalmers sealed tube mercury arc rectifiers cuts labor time and costs. All component parts are metal-enclosed and integrally connected into one complete unit. This unit can be located convenient to your dc load center to cut dc feeder cost and reduce dc distribution loss . . . requires no special concrete foundation. And because of its light weight, it can be installed on a balcony or elsewhere to conserve valuable floor space. Only connection to power and control leads and to cooling water supply is necessary to make unit ready for service.

Allis-Chalmers sealed tube rectifiers are offered in ratings from 200 kw at 250 volts to 1000 kw at 600 volts.

When you are planning a new dc power installation of *any* size, it will pay you to investigate the many cost cutting features of the Allis-Chalmers rectifiers. For complete details, call your nearest A-C sales office, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4144



MERCURY ARC RECTIFIERS

This 500 kw Allis-Chalmers factory packaged mercury arc rectifier unit is installed at a large Wisconsin plumbing fixture manufacturer. From left to right, the unit consists of dc feeder and cathode breaker compartments, rectifier tube compartment, rectifier transformer, and 12.5 kv ac switchgear compartments. Since its installation, this unit has greatly reduced costs of dc electric service to cranes, material handling equipment and machine tools.

A-C ALLIS-CHALMERS

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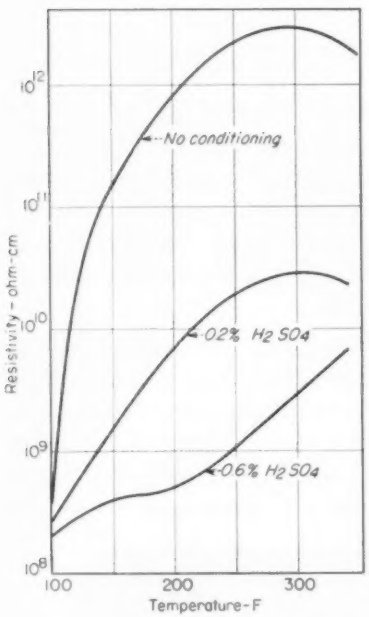
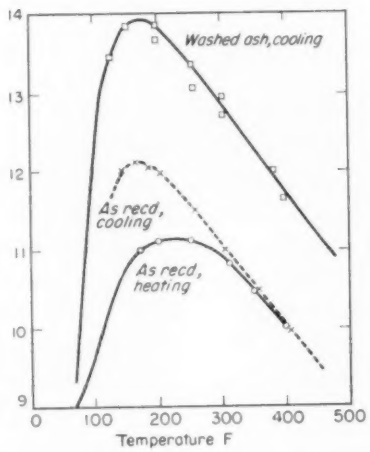
OIL PUMPABILITY



1 Heating destroys flyash conductivity indicating water is not sole factor



2 Sulfuric acid or fume proves a major conditioning factor in precipitating ash

Clean Air Studies Show Gains

Electrical Resistivity of Fly Ash. *By H J White, Research Corp.*

Electrostatic precipitation has long been accepted as a standard method of dealing with air pollution from industrial sources. These sources usually involve large gas-flow rates, high particle concentrations, high gas temperatures and other difficult operating conditions. This paper deals with an important phase of research in one of the largest fields of electrostatic precipitation—the removal of fly ash from pulverized-coal-fired boilers in the power generation industry.

The successful application of precipitators in the fly ash field over a period of many years and under conditions of constantly increasing gas flow and efficiency requirements, together with the trend toward the burning of poorer-grade coals, has required the solution of many difficult problems. Electrical resistivity of fly ash was chosen as the subject of this paper because it provides a good illustration of the advances which have been achieved in recent years through the application of fundamental research.

Fly ash is a complex mixture of inorganic compounds similar in characteristics to certain vitreous insulating materials which, in the pure state, have high electrical resistivities of the order of 10^{14} to 10^{15} ohm-cm. The conductivity of fly ash for temperatures below about 550 F depends basically on the presence of moisture and of certain chemical impurities in the gas which are adsorbed on the particles. The influence of varying amounts of these chemical conditioning substances is indicated by the fact that a wide range of fly ash resistivity is encountered in practice, ranging between about 10^6 and 10^{14} ohm-cm for measurements made in the laboratory, and between about 10^8 and 10^{11} ohm-cm for field measurements.

Research of the nature and identity of the chemical substances specifically responsible for conductivity in fly ash was initiated in the author's company laboratory in 1946. Prior to this time a large amount of laboratory and field information regarding fly ash conductivity had been accumulated and qualitative explanations for some of the phenomena involved had been advanced. However, the fundamental question regarding the nature and identity of the active conditioning substance or substances was completely unanswered, as were of course contingent questions regarding the amount of the conditioning substance required and the conditions and factors influencing its presence in boiler gases.

Fig. 1 reveals the rather striking result that the resistivity values measured for the cooling portion of the resistivity-temperature cycle are substantially higher than those obtained for the heating portion—strong evidence that some volatile substance other than water vapor is profoundly influencing conductivity. Isolation of this natural conditioning substance was one of the major objectives of the research.

Once the fact was established that the conductivity factor or agent is water soluble, the problem was reduced to that of identifying the effective chemical substance. Chemical analysis of the filtrates obtained from washing the various ashes showed that they were comprised primarily of sulfate and lime, with small quantities of alkali also present. It therefore appeared that the conditioning effect was caused either by the presence of the sulfate or the lime, with the former the most probable because of the previously observed effects of strong heating in destroying the conductivity of the ash.

Experiments provide conclusive evidence of the strong conditioning effect of sulphuric acid or SO_3 fume on fly ash under actual precipitator conditions, Fig. 2. The classical conditioning effects observed were: (1) The resistivity of the ash was lowered substantially by using only a fraction of a percent of acid, (2) this reduction in resistivity permitted operation of the test precipitator at much higher voltages without back corona or sparking, (3) visual observations showed that the efficiency of the precipitator increased greatly when the conditioning agent was used. *APCA Paper. No number.*

Unique Aspects of Air Pollution in Los Angeles. *By F E Littman and P L Magill, Stanford Research Institute.*

By most standards Los Angeles is a "clean" city. There is no soot or fly-ash, the dust fall is below average and the SO_2 concentrations are negligible. And yet, Los Angeles "smog" is one of the

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3. You get dependable application—Johns-Manville has set up a nationwide organization of J-M Insulation Contractors to serve you. These Contractors maintain staffs of insulation engineers as well as skilled mechanics thoroughly trained in J-M's proved application methods. You can have absolute confidence in their ability to apply J-M insulations correctly for trouble-free performance.

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More TECHNICAL BRIEFS

Begins on page 172

most talked-about air pollution conditions, and also one of the most thoroughly investigated.

The answer to these seemingly contradictory facts lies in a new type of pollution: the emission of apparently harmless gases which, under the influence of the abundant sunlight, gradually change into physiologically active constituents that cause discomfort and eye irritation to man, and serious damage to sensitive leafy crops. The salient determinants are meteorogical and topographical—the combination of sunshine, the Pacific inversion, and the mountain chains hemming the Los Angeles Basin on three sides. Yet, there is no reason to believe that this type of air pollution cannot or does not exist in other parts of the country. It may be that the unfavorable conditions merely occur much more frequently in Los Angeles. *APCA Paper. No number.*

The Role of the Area Survey in Dust Control. *By R B Engdahl, Battelle Memorial Institute.*

An attempt has been made to point out that on the dust phase of air pollution the many extraneous variables interacting at any point limit greatly the value of data taken at one point only. Simultaneous measurements at many points over an area are required to give a picture that will show the influence of the main variables of interest. The principal practical tool available for such an area survey is the simple dirtfall station. Some modifications show promise.

Equivalent means for getting the picture on suspended dust are not available. And the rapid weight-wise dilution of ultrafine, highly visible clouds of fine dust by the larger dust particles normally raised in an inhabited area make chemical identification of the visible components of the cloud extremely difficult. An unusual example of the difficulty of identifying the origin of finely deposited dust is the problem of distinguishing between flyash and meteoric dust.

The need is great for research to improve existing means for all kinds of dust measurement and to develop entirely new and more rapid means for such measurements. *APCA Paper. No number.*

Internal Flow Problems in Mechanical-Centrifugal Dust Collectors. *By E H R Pegg and D W Gibbs, Aerotec Corp.*

It has long been recognized by those familiar with multiple-tube centrifugal collectors that factors other than the design of the individual tubes are of paramount importance to proper operation, and, in the past, some installations have obtained efficiencies very much lower than would be obtained from independent tubes. This has been true of most designs of this general type and probably would be true of all if complete information could be assembled.

Barring any more obvious sources of trouble, the factor usually responsible for poor performance is so-called "recirculation." This refers to a secondary gas flow between tubes through the dust discharge section, and is caused by unbalance in the main flow through the tubes. The term recirculation, while not exactly descriptive of the conditions existing, has become established through usage and lack of a better term.

This flow through the dust discharge section leaves some tubes in the same direction as the dust discharge and enters others in the opposite direction. Flow in the same direction as the dust discharge is of little concern. However, flow opposite to the dust discharge upsets the normal action in the tube and inhibits or prevents the discharge of dust as well as re-entraining dust already collected by other tubes. Consequently, serious dust losses occur if the secondary flow is sufficiently large. A more commonly recognized similar condition exists if the hopper is under negative pressure and leakage into the hopper occurs.

Lengthy experiments developed a highly effective outlet shield for individual tubes. Just how these shields produce relatively high degree of balance is based partly on conjecture. However, it is apparent that in effect they form directional vanes which discharge the gas in the desired direction. This tends to streamline the flow and minimizes turbulence. Also, they have an aspirational effect on the flow from front to rear. The data shows that they have reduced the differential from front to rear in the gas outlet compartment practically to zero, at the same time they have promoted balance in the dust discharge compartment.

Probably because of the reduction of outlet losses they have caused only a minor change in the overall pressure drop. Another effect of the shields, which is not thoroughly covered in any data yet available, is that they tend to improve top to bottom gas distribution by more properly directing the outlet flow. *APCA Paper. No number.*

Gas Distribution in Electrostatic Precipitators. *By S W Randolph, Koppers Co, Inc.*

Uniform distribution of the gas through the treatment zone of the precipitator is essential for good operation and removal of entrained dust. This is true not merely because of the obvious possible observation that when the foul gas passes through only part of the treatment zone, that part is overloaded and the rest is relatively idle. It is also true because of the exponential character of the performance efficiency formula that describes the phenomenon of electrostatic dust collection.

Under a given set of circumstances there is a specific velocity or rate of gas flow required to produce a desired cleaning efficiency. A host of other design factors are, of course, involved but the velocity at which the gas is passed through the precipitator is a central and important one. Thus, if design curves show that a desired cleaning result on a given gas is obtainable at a treatment zone velocity of 5 ft per sec, the area of the cross section of the precipitator is defined. If, for instance, the volume of gas to be treated is 1,500 cubic feet per second, the cross-sectional area of the precipitator treatment zone must be 300 square feet, thus creating a 5 foot per second velocity.

Poor cleaning performance in a battery of four electrostatic precipitators cleaning blast furnace gas was attributed to poor distribution of the gas into the precipitator treatment zones. The precipitators were arranged in parallel along a manifold. The manifold was fed by a single main. Field operating conditions prevented adequate direct measurement of flow characteristics.

(*Continued on page* 244)

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from sources, not POWER.

Air Pollution Control Assn, annual meeting, Lord Baltimore Hotel, Baltimore, Md. May 24-29, 1953. Identified by initials APCA and obtainable in proceedings printed and distributed by R C Griebling, exec secy, 4400 Fifth Ave, Pittsburgh 13, Pa.

American Petroleum Institute, mid-year meeting, Hotel Commodore, New York, N. Y. May 11-13, 1953. Identified by initials API and obtainable through API, 50 W 50th St, New York, N. Y.

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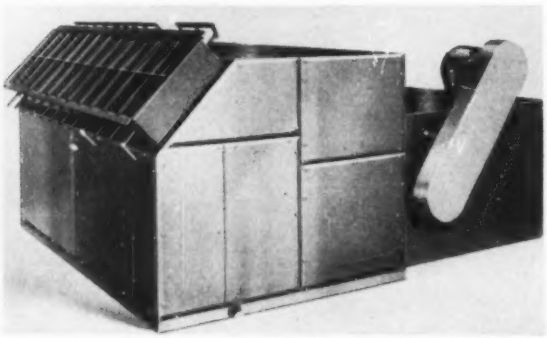


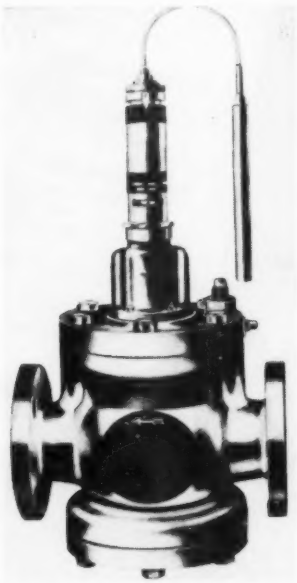
Multi-zone Conditioners Allow Variable Control

1011 • Multi-zone air conditioners provide both cooling and heating from single unit to any number of separate areas each with individual temperature control. Air leaves fan discharge and passes from cooling or heating coil to independently operating mixing dampers.

Cooling coils, for use with water or direct expansion refrigerant, are available in any number of rows of tubes. Standard steam coils, steam distributing coils and water coils are available for heating. Both sets of coils can operate year round so as to supply heating or cooling simultaneously to separate zones.

Equipment is offered in four models designed to serve 12 to 16 separate zones and ranging in capacity from 7500 to 18,000 cfm. Further information can be obtained from manufacturer.

U. S. Air Conditioning Corp, 3300 Como Ave SE, Minneapolis 14, Minn.

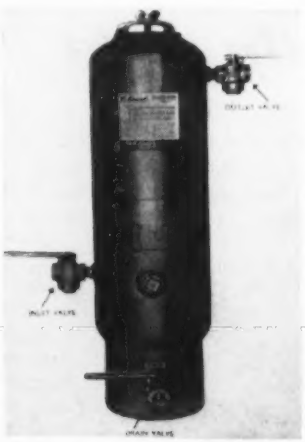


Temperature Regulators

1022 • Automatic temperature regulators incorporate design simplicity with advantages of liquid expansion principles. Self-cleaning strainers protect vital parts and complete internal porting prevents external damage manufacturer states.

Sizes range from 2 to 4 in. with temperature controls from 25 to 275 F. Bulletin ST-162 available from manufacturer.

Farris Staeon Corp, 627 Commercial Ave, Palisades Park, N. J.



Self-cleaning Dehumidifier

1017 • Self-cleaning dehumidifier for purifying compressed air and reducing humidity to very low dew point features several new developments. Self-adjusting nozzle and non-clogging aspirator stabilizes unit operation during varying air pressures and volumes. Baffle surfaces are enlarged to accommodate heavy impurities and momentary overloads. Self-cleaning drying agent covers wide temperature range.

Van Products Co, 3796 W 12th St, Erie 2, Pennsylvania

Indicating Control Thermometer

1025 • Low-unit-cost indicating pneumatic control thermometer features direct or reverse-acting "on-off" or limited throttler control units. Standard vapor or mercury filled thermal systems provide actuation. The unit, 11x11x4 in., is claimed especially suitable for manually regulated processes. Bulletin 6401.

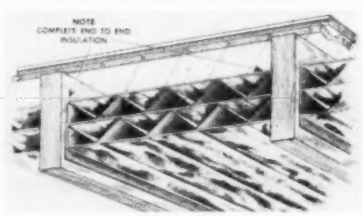
Minneapolis-Honeywell Regulator Co, 4494 Wayne Ave, Philadelphia 44, Pa.

Stepless Temperature Control

1016 • Stepless control holds temperatures with no under or over shooting, provides less rejects and lower production costs. Unit has no relay and supplies heating element with only enough power to hold temperature for which it is set. True temperature is indicated constantly on a 5-in. scale corrected for parallax. Models are available to handle loads from 300 va to 110 kva.

West Instrument Corp, 525 N Noble St, Chicago 22, Illinois

For more data on these items, use post cards p. 185. Identify your request with item number.



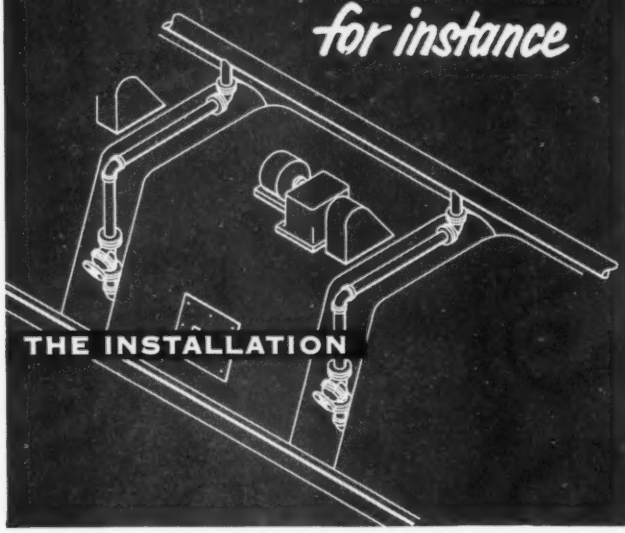
Aluminum Insulation

1046 • Multi-layered blanket of aluminum, fiber and air spaces, has been made to be of uniform depth throughout, including the area immediately adjacent to the beam or joist. The new insulation is available as type 6-Si, with three aluminum sheets, type 4-Si, with two aluminum sheets, and type 4-S Jr, made to fit spaces less than 2 in. deep.

Infra Insulation Inc, 525 Broadway, New York, New York

(*Continued on page* 178)

These Valves Last Longer-at Lower Cost ...on Toughest Water Services for instance



VALVE SERVICE RATINGS

SUITABILITY:	Ideal for the job
FEATURES:	Packless – No stuffing box
MAINTENANCE COST:	None
SERVICE LIFE:	Show no wear after more than 3 years
OPERATING RESULTS:	No leakage – easy operation
AVAILABILITY:	Regular Crane item – No. 1611

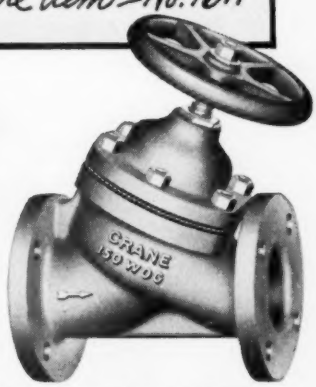
In a Southern public utility's power plant, with Crane Diaphragm Valves on water spray lines for cleaning traveling screens on condenser water intake.

THE CASE HISTORY

Both raw Mississippi River water and deep well water are used for the cleaning spray to the screens. The valves are exposed to a combination of river water sand erosion, and well water sodium chloride corrosion. These conditions caused stem packing leaks, difficult valve operation, and also corroded the steel bonnet bolts. Maintenance costs were excessive.

The trouble was stopped by installing Crane No. 1611 Packless Diaphragm Valves featuring separate disc and diaphragm design. After more than 3 years' operation, they show no effects of service. They operate smoothly and seat tightly. Crane Diaphragm design eliminates leaks entirely, and no maintenance has been needed. Based on this performance record, additional Crane Diaphragm Valves have been installed.

THE VALVE



In Crane Packless Diaphragm Valves, the diaphragm seals the working parts from all erosive or corrosive fluids. Need for a stuffing box is eliminated. Choose these valves from a wide variety of body and trim materials, lined or unlined, for better, lower-cost handling of countless corrosive, erosive, or ordinary services. See your Crane Catalog or your Crane Representative.

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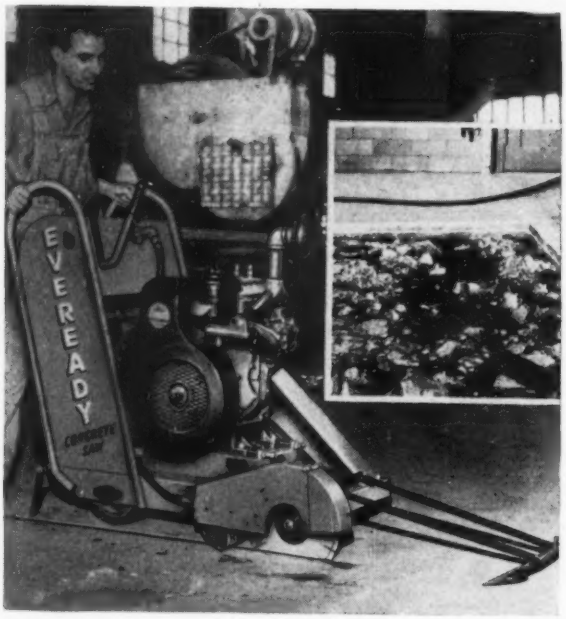

Concrete Saw Cuts Maintenance, Construction Costs

1009 • New concrete saw has a hydraulic control for lowering the blade gently into the cut at a controlled rate of speed. Other features claimed include automatic floating action of the saw wheels to prevent binding or tilting when operating on uneven or broken surfaces; depth control lock; foot brake; dashboard controls.

Sawing before breaking out concrete or asphalt for floor patch work, machinery bases, utility trenches, etc. provides square solid shoulders against which to rebuild. This is said to eliminate weak feather-edging with resultant spalling and future maintenance. Unit is also recommended for sawing contraction joints in new construction. Manufacturer claims saw can cut maintenance costs as much as 50 percent.

Eveready BrikSaw Co, Dept 277, 1509 S Michigan, Chicago, Ill.

Power Sweeper

1033 • New power sweeper reportedly does the work of 3 to 12 handsweepers and has capacity of 100,000 sq ft per hour in open areas. Speed ranges from 2 to 6 mph. High speed 36-in. brush and 720-cfm fan pick up dirt and dust. Sweeper drives like a car, has forward-reverse control and turns in 5-ft radius. New internal emergency brake is standard equipment.

G H Tennant Co, 2566 N 2nd St, Minneapolis 11, Minn.

Recess Lighting Fixtures

1038 • Round incandescent fixtures provide low cost recess light for wide range of applications. Durable aluminum reflectors are unbreakable and manufacturer claims they won't become brittle or tarnish with age or heat. Reflectors are available in 30 and 70 degree beam design in 3 sizes to handle lamps from 60 to 300 watts. Units are packaged with plaster and ceiling rings and louvers.

Edwin F Guth Co, 2615 Washington Ave, St. Louis 3, Missouri

Set-Screw Fittings

1035 • Set-screw fittings for non-water tight installations reduce assembly time, manufacturer claims, and provide firmer grip with simple case hardened cup screw operation. Installation with ordinary screw driver eliminates use of special wrenches.

Libco Electric Products Co, Liberty St, Corner Worth, Central Falls, R. I.

Vibration Isolator

1047 • Type 915 *Barrymount* is designed to provide vibration and noise isolation above frequencies of 20 cps, for equipment applying static loads of 15 to 200 lb per unit isolator. Type 915 provides from 70 to 90% isolation at 30 cps (1800 rpm), and more at higher frequencies, manufacturer claims.

Unit is useful in reducing vibration from motor-generator sets, high-speed compressors, fans, blowers, etc. Bulletin 532.

Barry Corp, 700 Pleasant St, Watertown 72, Massachusetts

Metal Detector

1048 • *Private eye* electronic detector will locate buried metals and minerals, can be used for spotting underground pipes, conduits, etc. Unit is enclosed in a baked enamel aluminum case. It uses low-voltage radio batteries and consists of a transmitter and receiver that can be folded in suitcase fashion when not in use.

Radiac Co, Inc, 489 Fifth Ave, New York 17, New York

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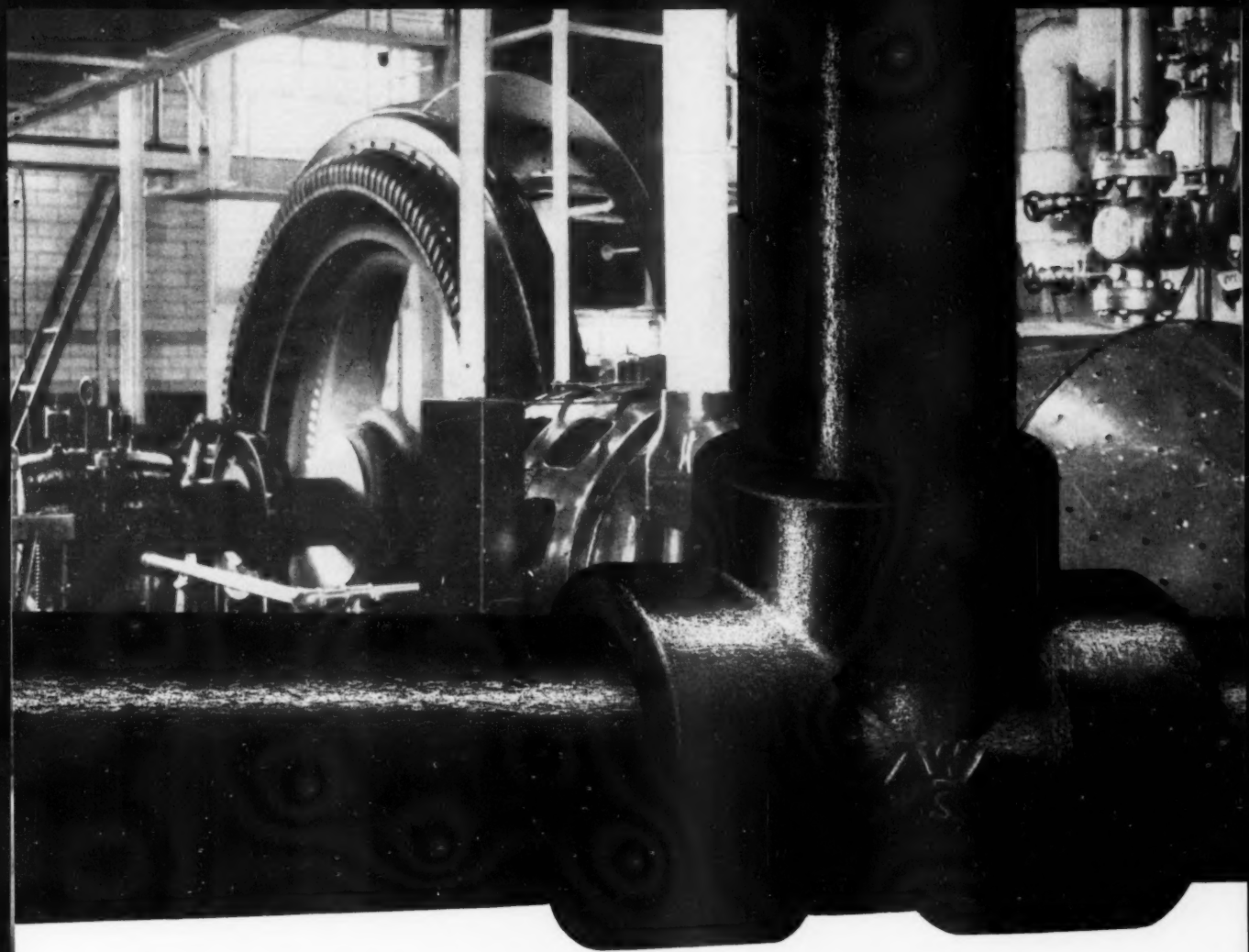

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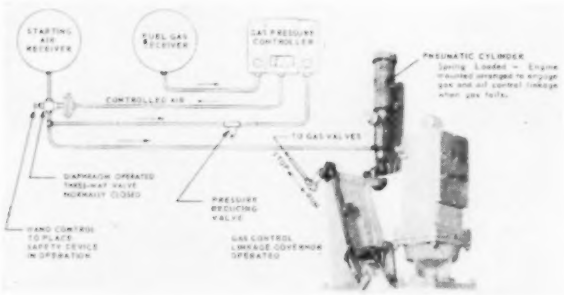
More EQUIPMENT NEWS

Begins on page 176



Automatic Fuel Switcher Eliminates Shutdowns

1010 • Automatic fuel switcher for dual-fueled diesels eliminates shutdowns resulting from manual changeover during emergencies. Operating on gas with pilot oil or 100% oil, switcher places engine under control of governor with full travel at its best efficiency.

Switch acts immediately when gas pressure in main line drops below predetermined level, usually 25 psi. It closes gas metering valves instantly and shifts linkages that place fuel pumps under control of governor at setting required for load at that moment.

Until time failure occurs, metering valves remain under control of governor. At instant of failure, air pressure in pneumatic cylinder is released and plunger engages changeover linkages. This action closes metering valves, opens fuel pumps and transfers governor control to fuel oil system exclusively.

When gas supply is again normal, engine can be restored to gas under control of governor and automatic switching cycle is ready to be repeated.

Worthington Corp, Harrison, N. J.

Multiple Recorder

1004 • New instrument records in sequence the values of three variables at 20 different points. Any physical quantity for which a sensing element can provide an electrical output can be adapted to it, manufacturer states. Some of the variables that can be measured are current, power, strain, humidity, liquid flow, liquid level, speed, displacement.

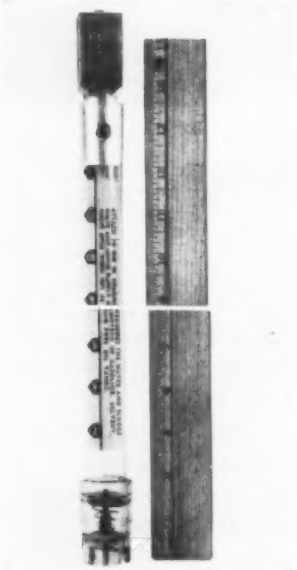
Unit can be set to different combinations of manual or automatic operation. It can record from one to three variables, and can be adapted to as many as 60 variables.

Hastings Instrument Co, Inc, Hampton, Virginia

Preheat Calculator

1049 • Calculator uses slide-rule principle to determine preheat temperature required when welding hardenable steels. Calculates preheat in simple steps based on chemical analysis and thickness of the steel.

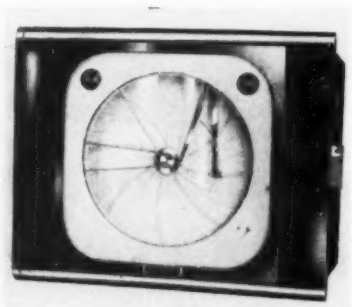
Lincoln Electric Co, Cleveland 17, Ohio



Storage Tank Gage

1029 • Fastened permanently to end of standard liquid storage tank measuring stick, gage obtains exact sample of bottom content of tank. Trip valve closes upon contact with tank bottom and permits sample to be raised. Parts are not affected by any petroleum product. Unit is guaranteed against breakage and leakage for one year manufacturer states.

Visa-Test Sales Co, 1515 Alturas Dr, Burlingame, California



Program Controllers

1005 • New controllers regulate temperature according to a predetermined schedule of changing values. Any desired program, such as heating, soaking and cooling can be maintained accurately, manufacturer claims. Plastic cam is cut to contour required. It can be interchanged easily with cams of different contour for different cycles. Bulletin P1255.

Bristol Co, Waterbury 20, Conn.

Pipe Labels

1001 • Vinylite plastic labels can be made up in any color, with any wording to suit the installation. User snaps them into place around the pipe. Manufacturer claims the plastic is resistant to most corrosive conditions.

Wilmington Plastics Inc, 810 South Heald St., Wilmington 1, Del.

For more data on these items, use post cards p. 185. Identify your request with item number.

Zero Speed Switches

1028 • Zero speed switches featuring low speed control will actuate signal circuits on increasing shaft rotation of 15 rpm and decreasing speed of 8 rpm. Units are self-lubricating, have hydraulically-driven mechanism and magnetically coupled electrical contacts. They can be driven at speeds through 5000 rpm at temperatures from –20 F to 250 F. Applications include use as conveyor controls and interlocks, operation of braking equipment and adaptation as plugging switches.

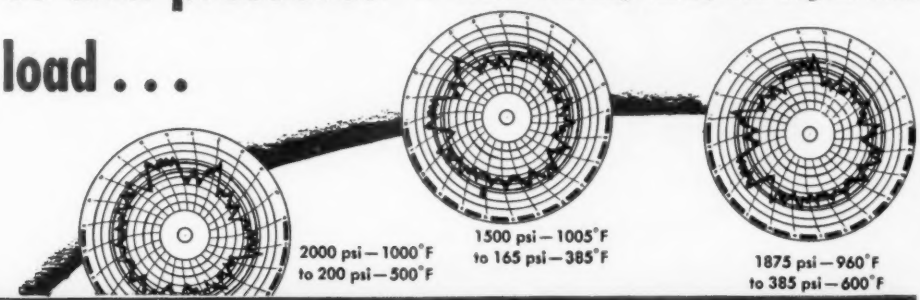
Winterburn Mfg Co, Putnam, Conn.

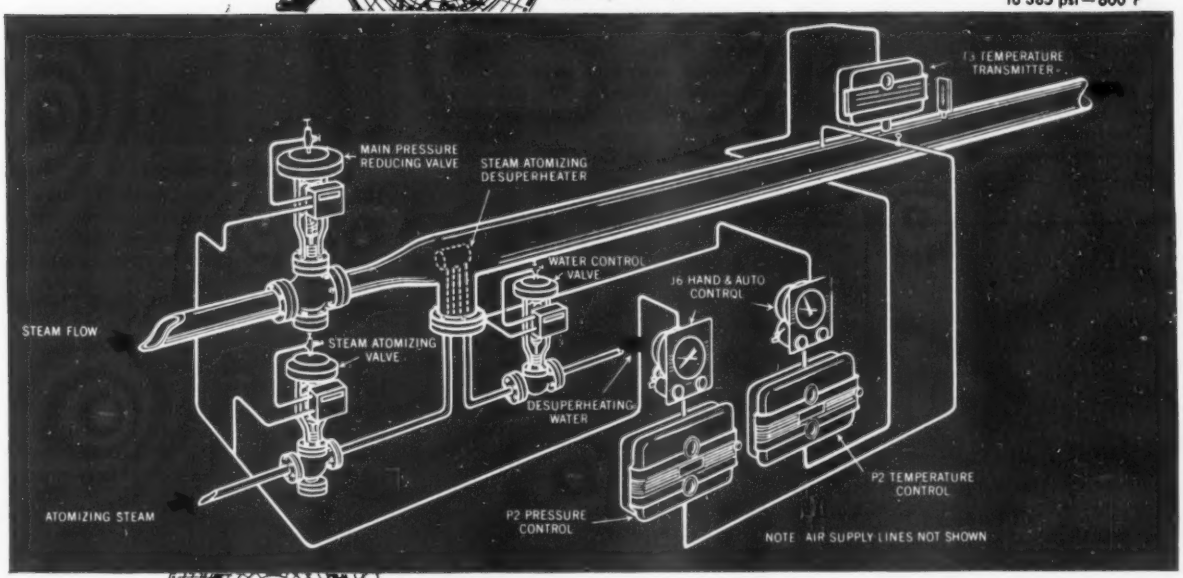
(*Continued on page* 182)

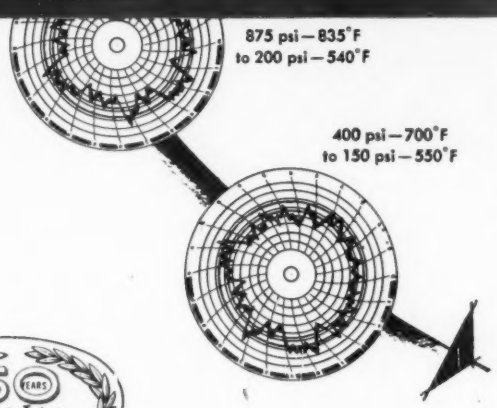
Swartwout RDC Systems maintain accurate control of temperatures and pressures under any load . . .

Performance of Swartwout RDC Systems—Reducing, Desuperheating and Controls—is precise and stable under *any rate of change of load of any magnitude.* The pressure and temperature reductions shown are taken from representative Swartwout RDC installations.

In most installations, pressure is held to within ±½#, temperature to within ±3°F or less. Temperature control unit provides wide throttling range with automatic load compensation for close control. Steam atomizing desuperheater gives narrow-angle dispersion of cooling water outside atomizing head. Swartwout reducing valves, with large-diameter







stems for long life, have nozzle-shaped passages that minimize turbulence, noise, vibration for longer valve life.

No matter how stringent your control requirements, no matter how rapidly load changes—turn your problems in reducing, desuperheating and control over to Swartwout. We have been solving steam problems for over 50 years.

A-7546

50 YEARS Service to Industry The Swartwout Company 1903 - 1953

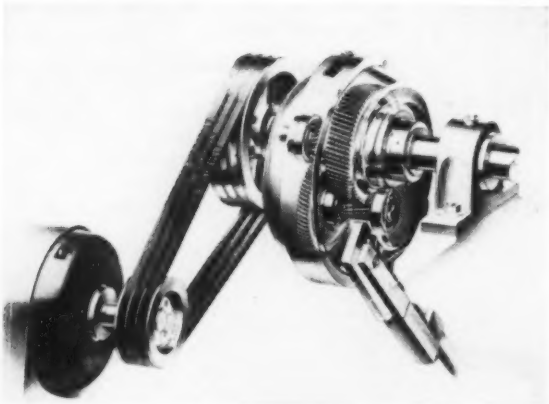
Swartwout

POWER PLANT EQUIPMENT
PROCESS INDUSTRY CONTROLS
INDUSTRIAL VENTILATION

SEND FOR BULLETINS S-21-E, S-22-CA, S-198 & S-100-K • THE SWARTWOUT COMPANY, 18511 EUCLID AVENUE, CLEVELAND 12, OHIO

More EQUIPMENT NEWS

Begins on page 176



Shaft-Mounted Speed Reducer

1006 • *Shaft-King* speed reducers provide 13 to 1 speed ratio, are adaptable to any shaft size up to 3-15/16 in. They can be mounted directly on the driven machine shaft with standard clearances. Available in seven sizes from fractional to 42.8 hp. Speed ranges from 11 to 154 rpm.

Two trains of helical gears reduce driven shaft speed to obtain 13 to 1 ratio. Gearing and bearings are splash-lubricated continuously by the high-speed gear and the counter-shaft pinion that operate in an oil reservoir. Both input and output shafts are above oil level.

Optional equipment includes a torque-arm overload release and an internal backstop for protection against sudden overloads and for prevention of reversing.

American Pulley Co, 4200 Wissahickon Ave, Philadelphia 29, Pa.

Oil Coolers

1050 • New line of oil coolers uses patented longitudinal inner fins, is suitable for oil-side pressures up to 250 psi, temperatures to 300 F, according to the manufacturer. Water side is suitable for pressures to 150 psi.

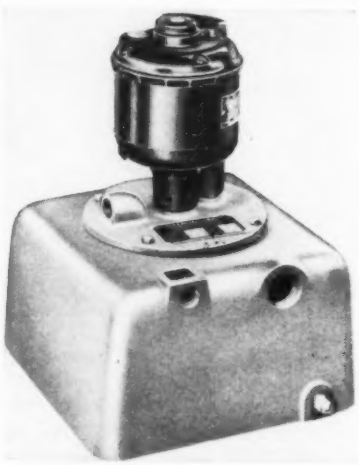
The inner-finned element is all copper, and removable for cleaning and replacement. Applications include diesel and gasoline engines, turbines, gears, transformers, etc.

Heat-X-Changer Co, Brewster, N. Y.

Conduit Supports

1002 • *Unistrut* system of electrical and mechanical supports consists of steel channel and fittings, tubing, conduit and cable clamps, concrete inserts and other standard parts that can be assembled easily and erected on the job, manufacturer claims. Assembly is by a simple nut and bolt method that eliminates need for drilling or welding.

Unistrut Products Co, 1013 West Washington Blvd, Chicago 7, Ill.



Condensate Return Pump

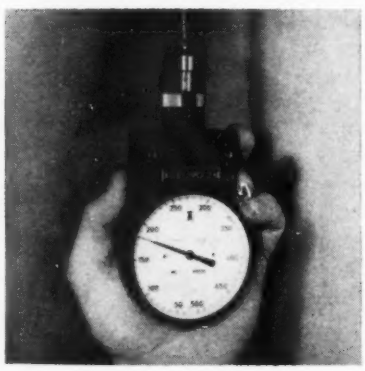
1015 • Extremely compact condensate return pump occupies less than 1½-sq ft space and has return inlet less than 7 in. above floor. Unit, with either cast iron or steel tank, has capacity of 3000 sq ft EDR, 45 gpm and up to 20-lb discharge pressure. Simplified construction permits easy removal of entire motor, pump and switch assembly.

Sterling, Inc, 3738 W Holton St, Milwaukee, Wisconsin

For more data on these items, use post cards p 185. Identify your request with item number.

CHECK THESE TOO!...

Pneumatic Ejector ..... p 194
Duplex Strainers ..... p 198
Voltage Regulator ..... p 202
Boiler-burner Unit ..... p 208
Automatic Sampler ..... p 210
Welding Equipment ..... p 212
High Voltage Transformer ..... p 214
Portable Generator ..... p 216
Plastic Filters ..... p 218



Hand Tachometer

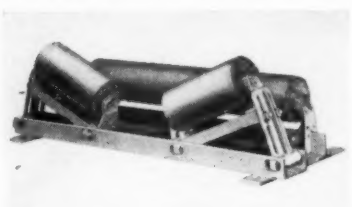
1020 • Portable tachometer checks rpm of motors, machinery, revolving shafts, etc. Rubber tip is pressed against shaft and rpm are read from dial. Instrument measures from 40 to 50,000 rpm.

Montgomery & Co, Inc, 53 Park Place, New York 7, N. Y.

Air Hoist

1051 • Model 7700 air hoist lifts 1000 lb at 40 fpm, manufacturer states, weighs 28½ lb. Throttle control regulates rate of lift to any speed from 0 to 40 fpm. Unit has safety brake that automatically locks when control is released.

Aro Equipment Corp, Bryan, Ohio

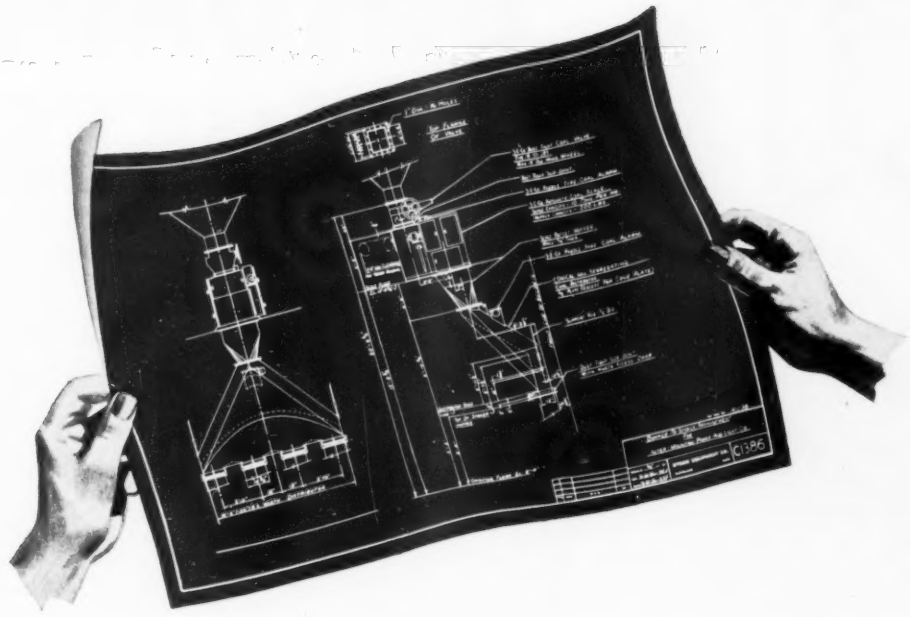


Variable Idler

1031 • Variable troughing belt conveyor idler provides smooth belt transition between troughing idlers and flat pulley. Angle of inclination of concentrator rolls is adjustable from 20 degrees to fully horizontal. Series 100 comes in 7 belt widths from 24 to 60 in. Series 200 covers 6 widths from 36 to 72 in. Booklet No. 2416 available from manufacturer.

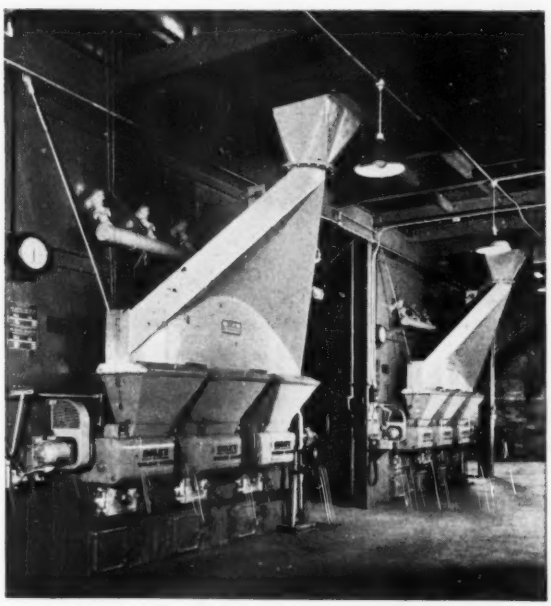
Link-Belt Co, 307 N. Michigan Ave, Chicago 1, Illinois

(*Continued on page* 194)



The Power Engineer With Blue Print

S-E-Co. CONICAL Distributors with dust-tight slip-joint connections to stoker hoppers at the J. Greenebaum Tanning Company, Milwaukee, Wisconsin. S-E-Co. Automatic Coal Scales and Under-Bunker Drag Conveyor are located on floor above.



sees how well-designed Bunker to Stoker Equipment results in good coal flow. By careful planning, coal segregation and coal stoppage are eliminated. Thus, the plant operator enjoys efficient and reliable stoker operation.

You can depend on Bunker to Stoker Installations as designed and furnished by Stock Equipment Company to give you the best in originality combined with proven design. These installations feature the S-E-Co. Coal Valve and the S-E-Co. CONICAL Non-Segregating Coal Distributor which is the only stationary means of delivering coal to a stoker without segregation. They also include the S-E-Co. Automatic Coal Scale to give true weights of coal burned. These unexcelled products are applied with a know-how that has been gained through years of experience in pioneering and specializing in this field.

Call on Stock Equipment Company to help you with your layout of new Bunker to Stoker or Pulverizer Installations or in the renovation of your existing facilities.

STOCK EQUIPMENT COMPANY

745P HANNA BUILDING

CLEVELAND, OHIO

Specialists in Bunker to Pulverizer or Bunker to Stoker Equipment

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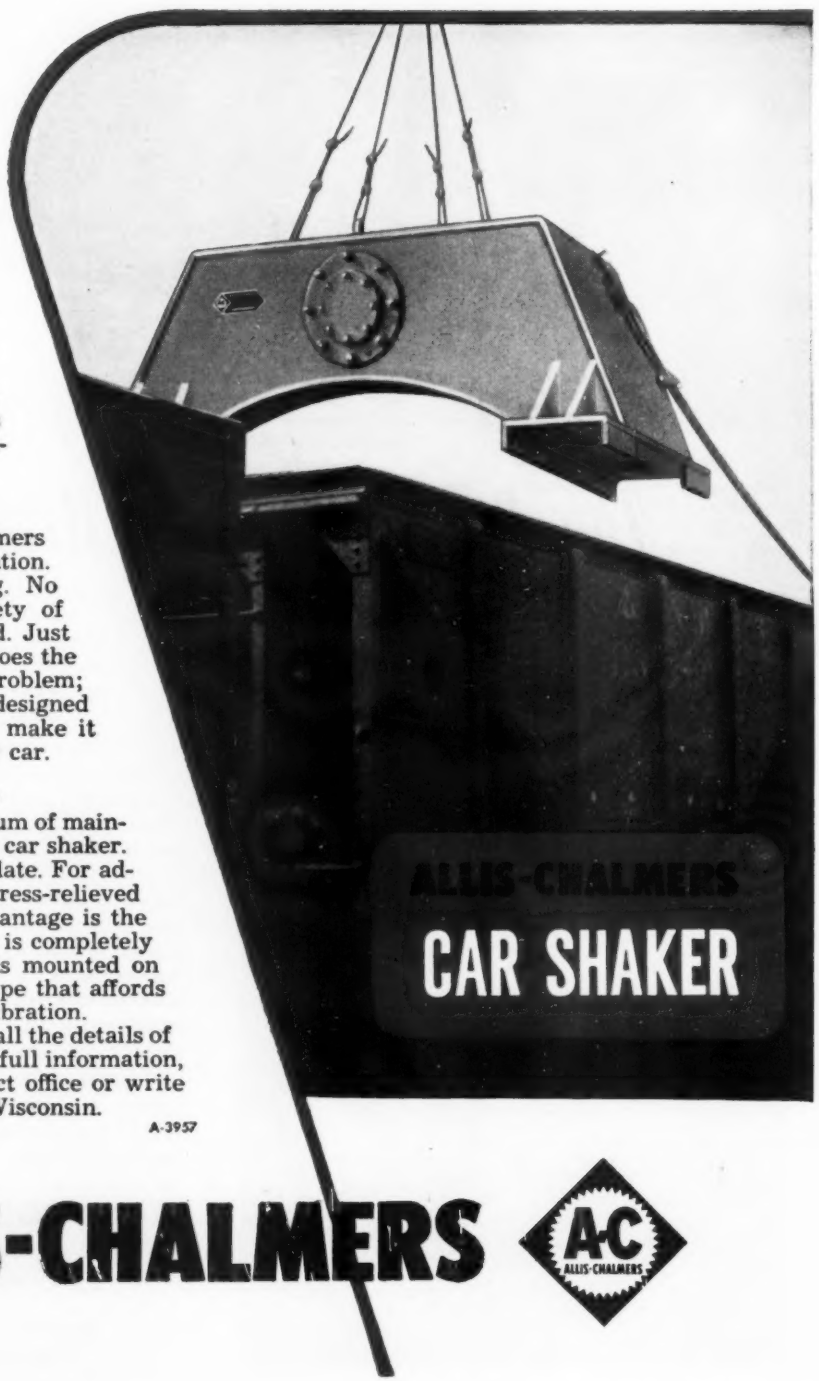
CUT UNLOADING COSTS



You can save time and money using Allis-Chalmers car shakers for unloading cars. Here are two examples: **(1)** You can unload cars of wet sand or like materials in 1½ to 2¼ minutes; **(2)** you can unload coal in 1 to 6 minutes, depending on surface moisture.

In fact, you can unload any material in minutes, even if it is damp, compacted or in a partially frozen condition.

One-Man Operation

Best of all, using an Allis-Chalmers car shaker is a one-man operation. No more pounding or digging. No more worrying about the safety of men inside cars being unloaded. Just press a button; the car shaker does the rest. There is no positioning problem; Allis-Chalmers car shakers are designed to hang level, and wide shoes make it easy to engage any size hopper car.

Low Maintenance

You'll get long life and a minimum of maintenance with an Allis-Chalmers car shaker. Sides and top are heavy steel plate. For additional strength, the body is stress-relieved after welding. Another big advantage is the power arrangement. The motor is completely enclosed in the body. And it is mounted on rubber shear mountings of a type that affords maximum protection against vibration.

It will pay you to investigate all the details of Allis-Chalmers car shakers. For full information, consult your nearby A-C district office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-3957

ALLIS-CHALMERS

Preceding pages tell you what's new in plant equipment. Each item is numbered. For more info on any of them, write in their numbers here

New free catalogs and bulletins are listed beginning on back of this page. To order those you want, write in their item numbers here

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This month's FREE Literature

AIR CONDITIONING

1 **Air handling** units for industrial and commercial heating, ventilating, air-conditioning applications featured in 6-page, 2-color folder. Construction, installation specs included. Bulletin 1600, Westinghouse Sturtevant Div, Dept T-071, 200 Readville St, Boston 36, Mass.

2 **Centrifugal blowers** and exhausters for air or gas handling covered in 32-page, 2-color booklet. Photos, sectionals, complete application data included. Bulletin B-6, Lamson Corp, Syracuse, N. Y.

3 **Multi-Louvre dryer** for heat drying coal described in 8-page, 2-color booklet. Contains nine case histories from mines in several states. Photos, performance data included. Book 2466, Link-Belt Co, 307 N Michigan Ave, Chicago 1, Ill.

4 **Refrigeration fittings,** valves and accessories, charging lines, driers and strainers presented in 18-page catalog. Photos, complete specs included. Refrigeration Catalog R-600, Madden Brass Products Co, 1111 N Franklin St, Chicago 10, Ill.

BOILERS & AUXILIARIES

5 **Multi-stage centrifugal** blowers and exhausters discussed in 2-color flyleaf. Application data, performance curves, specs included. Bulletin A-932, U. S. Hoffman Machy Co, Ltd, Newmarket, Ont.

6 **Spray-type deaerating** heaters explained in 8-page, 2-color booklet. Installation photos, cutaways, sectionals show design and operation. Flow charts, full specs included. Bulletin WC-101A, Graver Water Conditioning Co, Dept 10, 216 W 14th St, New York 11, N. Y.

7 **Boiler feed control,** a three-influence instrument-type for high duty boilers, described in 4-page, 2-color folder. Photos, installation diagrams, specs, included. Bulletin 1013, Copes Vulcan Div, Continental Fdry & Mach Co, Erie 4, Pa.

8 **Boiler-burner** units—oil, gas and oil-gas combination—analyzed in 14-page, 3-color booklet. Photos, sectionals, cutaways show design features. Performance data and complete specs included. Booklet B-3133, Titusville Iron Works Co, Titusville, Pa.

9 **Spreader stokers** for use with boilers and steam generators from 5000 to 75,000-lb capacity featured in 14-page, 2-color catalog. Photos, sectionals, design and installation specs included. Detroit Stoker Co, General Motors Bldg, Detroit, Mich.

ELECTRICAL & MECHANICAL CONTROLS

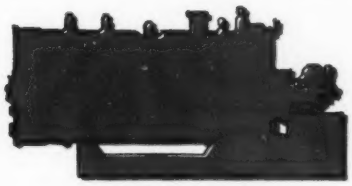
10 **Electronic** counters, photo-electric equipment, relays, timers, liquid level equipment and other controls for industrial and test equipment covered in 4-page leaflet. Folder #453, Haledy Electronics Co, 57 William St, New York 5, N. Y.

11 **Case studies** explain how standard packaged electronic controls solve many industrial problems in new edition of book entitled, *Cutting Production Costs with Electronic Controls.* Photoswitch, Inc, 77 Broadway, Cambridge 42, Mass.

12 **Remote** supervisory control system described in 4-page, 2-color folder. Equipment is designed for operation over wirelines, microwave, or radio lengths to provide on-off control, switching or signaling at one or several remote points. Hammerlund Mfg Co, Inc, 460 W 34th St, New York 1, N. Y.

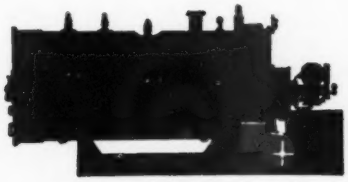
(Continued on page 268)

HOW SUPERIOR SOLVES YOUR STEAM PROBLEMS



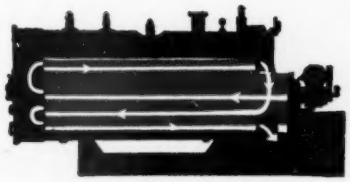
A COMPLETE PACKAGE

Completely factory-assembled and tested, a Superior Steam Generator is backed by undivided responsibility.



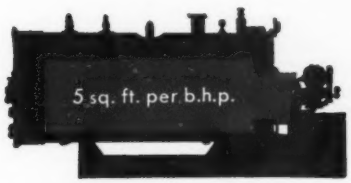
INDUCED DRAFT THAT'S BUILT-IN

... eliminates need of an expensive chimney ... Multiple fans draw evenly on all tubes, reducing maintenance.



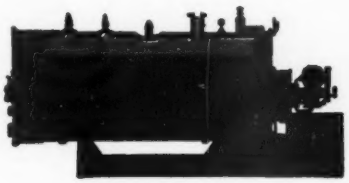
4-PASS, DOWN-DRAFT DESIGN

High gas velocities produce high efficiency. Down-draft design promotes rapid evaporation, quicker steaming.



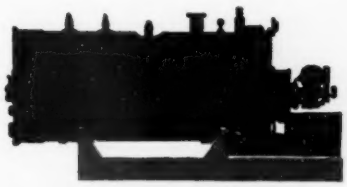
AMPLE HEATING SURFACE

A minimum of 5 sq. ft. of heating surface per boiler horsepower assures maximum efficiency at full rated capacity.



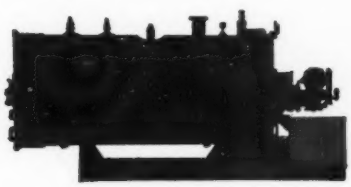
RESERVE CAPACITY

Greater steam space and large evaporating surface provide ample reserve capacity & better than 99% dry steam.



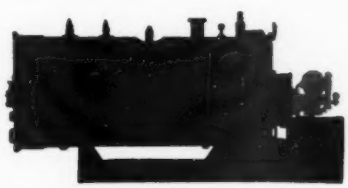
NO EXPENSIVE FOUNDATION

Built on a rigid channel iron base, a Superior Steam Generator needs only a floor capable of supporting its weight.



BUILT-IN CONTROLS

All controls essential to completely automatic operation are factory-wired into an easily accessible control panel,



BURN OIL, GAS, OR BOTH

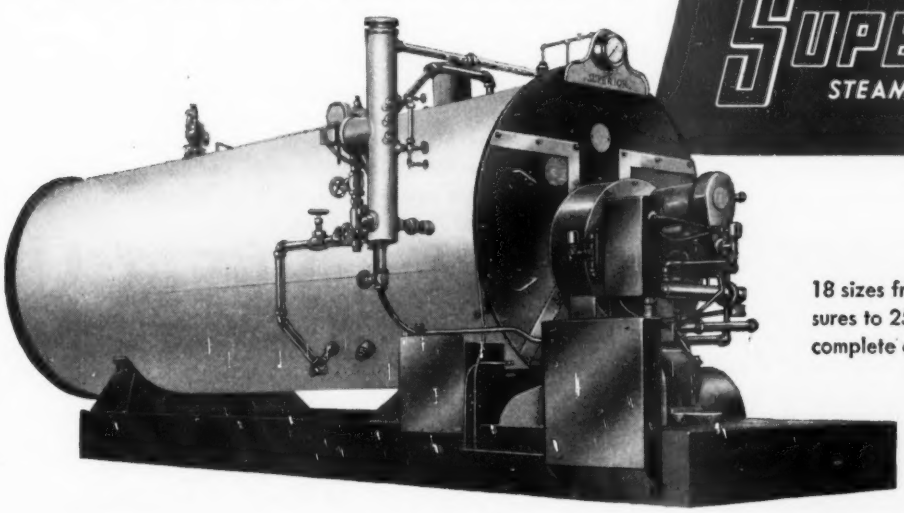
Superior Burners burn oil or gas or a combination of both ... changing from one fuel to the other in seconds.

Superior Steam Generators are the ideal choice for a new steam plant ... the simplest answer to expanding your present plant ... the easiest solution to replacing obsolete boilers.

Guaranteed to develop maximum rated capacities at thermal efficiencies in excess of 80%, their design embodies features which insure long-lived dependability and maximum fuel economy.

for performance you can **BANK** *on*

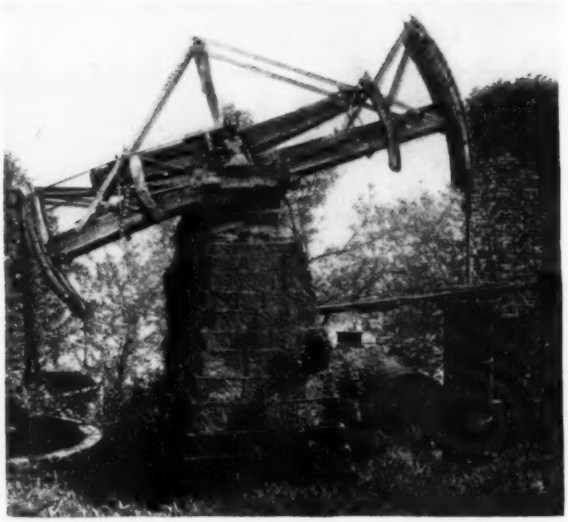
SUPERIOR
STEAM GENERATORS



18 sizes from 20 to 600 b.h.p. for pressures to 250 p.s.i. or for hot water. For complete details write for Catalog 500.

SUPERIOR COMBUSTION INDUSTRIES INC. TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

George Edwards' Scrapbook



A **man without mirth** is like a wagon without springs, in which one is caused disagreeably to jolt by every pebble over which it runs. —Henry Ward Beecher

I see where Dow Corning Corp is making **paints to withstand 350 to 1000 F.** It's all done with silicone resins. They say in the near future modified silicones will go into high gear for paints, varnishes and enamels many times as weatherproof and colorfast as our best finishes now.

Already these semi-inorganic paint resins are used on space heaters, jet engine parts, red-hot mufflers, stoves, ovens, powerhouse stacks and process equipment.

How do I know? Like Will Rogers, I read the papers—in this case the technical publications. That's about the only way a busy engineer can keep up with these new developments popping up every day. Fact is, I got this one from an ad.

Fear not that thy life will come to an end, but rather fear that it shall **never have a beginning.** —Cardinal Newman

Flying to the National Safety Convention recently, I learned something interesting about **industrial insurance.** A plant engineer friend on the plane told me that six years ago he broke down and recommended that his firm invest $10,000 for a complete sprinkler system in one wing of their plant.

Interesting thing is that in the first five years this system paid for itself in reduced insurance rates. "And I've been considering the investment for 22 years," admitted my friend.

Here's a case where "a fool and his money are soon parted" just by trying to hold on to his cash.

This old photo of "Fairbottom Bobs" turned up in my album. It's a Newcomen pumping engine at Fairbottom Valley in Bardsley, England. Built in 1750, she pumped water from Cannel Mine from 225-ft depth.

Cylinder is 27.4 in. by 6-ft stroke. Air was prevented from leaking past piston by packing of peat or hemp. Injection jet discharged directly into the cylinder.

In a Newcomen, with piston at top of stroke and cylinder filled with steam, cold water was injected into cylinder, condensing steam and permitting atmospheric pressure to force piston down. Weight of pump rods down in mine returned piston to top of cylinder and action was repeated.

I'm showing you readers this because it's always interesting to see where we power engineers started from.

"Facts are the **least developed** of all our natural resources." —Owen D Young

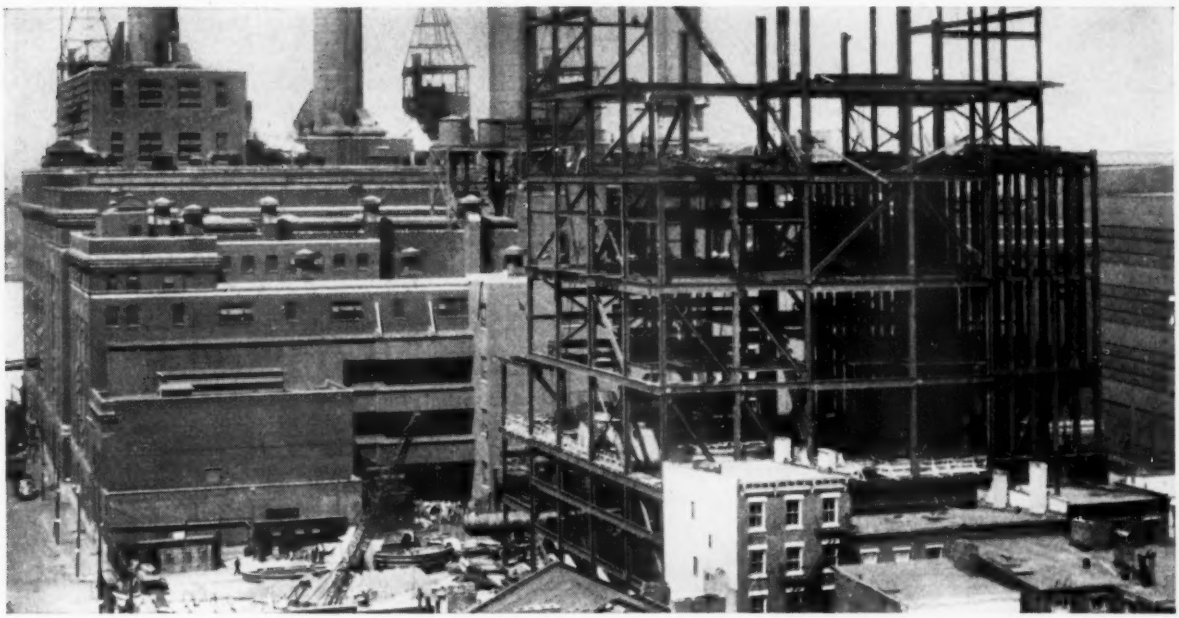
After reading that 16 pages on Hard Surfacing in March Power, I had a talk with a welding engineer friend. He said, "It will be no more than a dozen years until **80% of all welding,** whether for maintenance or for production and fabrication work, in this country will be done by automatic equipment."

Sounds like the hand torch and arc soon will be in the same class with the hand file. I remember when the best boilers were hand riveted, hand calked, and all curved surfaces filed by hand to make them a snug water-tight fit. I'll bet the average boiler maker today doesn't know what a hand file is. Maybe it's just as well.

George Edwards
Engineer

CHEMICAL CLEANING REMOVED MILL SCALE FROM BOILER AFTER ERECTION

Dowell service gave quick, effective cleaning assuring more efficient operation



To provide more extensive service for its customers, a large power company installed a new 1,370,000 lb. per hour boiler. Specifications on this equipment called for Dowell Chemical Cleaning Service to remove the mill scale from the boiler *after erection*.

To remove the mill scale, Dowell engineers filled the boiler with solvents especially designed for the job. Using Dowell's equipment, manpower, and pump trucks, the entire cleaning job was performed in a few hours.

The removal of mill scale *after* equipment is erected can eliminate much of the extra care required in the handling of previously sand blasted or pickled tubes. It may also substitute for the grease-removing alkaline pre boil, thus saving considerable time and money. Unless it is removed, mill scale may retard heat transfer, slough off abrading particles, and act as a base for further corrosion.

Maintenance engineers in industrial plants throughout the country have learned to rely on Dowell Service for fast, effective and economical cleaning of their operating equipment. How about you?

Experienced Dowell engineers are available to make estimates on your particular problems. Call Dowell today, or write directly to Tulsa, Dept. J23.

DOWELL SERVICE

Over 100 Offices to Serve You with Chemical Cleaning for:

Boilers • Condensers • Heat Exchangers • Cooling Systems
Pipe Lines • Piping Systems • Gas Washers • Process Towers
Process Equipment • Evaporators • Filter Beds • Tanks

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED • TULSA 1, OKLAHOMA

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

The Reader AUDITED PAID ABC CIRCULATION *His Mark*

THE ABC that appears in the symbol at the top of this page stands for Audit Bureau of Circulations. The symbol itself is an emblem of cooperation, in which every subscriber to this magazine has an interest.

The Audit Bureau of Circulations is a voluntary, non-profit, cooperative association. It was founded in 1914 and now consists of 3450 advertisers, advertising agencies and publishers in the United States and Canada. This magazine is proud to be a member.

ABC originally was set up to help take the racket out of publishing, to eliminate the waste and guesswork then so prevalent in publishing and advertising, to establish order and confidence in place of the misunderstanding and misrepresentation that arose from unverified circulation claims and dubious circulation practices. Its mission was to protect the interests of both readers and advertisers.

THIS IT DID by first defining the term "paid circulation." Then it established standards and rules to govern subscription sales practices and records. Finally it set up an auditing organization to verify the claims and report the facts concerning the circulation of each member publication. It now maintains on that job a working staff of sixty-five full-time auditors. So the ABC symbol has become the hallmark of circulation standards and advertising values. Each member publication must maintain those standards if it wishes to retain its membership and display the ABC symbol.

This ABC audit is no perfunctory affair. When a business publication, such as this one, becomes a member of the Bureau, it agrees that the auditors shall have "the right of access to all books and records." Their inspection, therefore, may cover any part of its operations. Original subscription orders, payments from subscribers, paper purchases, postal receipts, arrears of payments, and many more items are painstakingly checked by the auditors. In many instances they go behind the records to seek verification from subscribers themselves as to the terms of their subscriptions.

IN DOING ITS JOB, ABC has created many values for both publishers and readers as well as for advertisers. That is because the publication that becomes a member of ABC thereby offers the strongest possible guarantee of its primary devotion to the interests of its readers. The function of a business magazine is to be useful to its readers. When this service is rendered by an ABC publication, it is constantly subject to the practical test of reader acceptance and approval. As each subscriber has the right to purchase or refrain from purchasing an ABC publication, that collective right confers upon the readers the power to say whether or not the publication will survive. Thus the report on its ABC audit provides the most direct assurance that a publication stays in business only because of a voluntary demand by readers who find its editorial service responsive to their needs.

Naturally, the editor of each business publication follows closely the score thus racked up by his paper in its ABC reports. In the scope and tone of his editorial coverage and treatment, in the selection and presentation of his editorial content, he must constantly labor to maintain and enhance the readers' acceptance of his efforts. That is why the editorial standards established by ABC publications set the editorial standards for all publishing. That is how the ABC constantly stimulates its member publications to become even more useful to their readers.

AND THAT IS WHY the ABC symbol has become the Mark of the Reader, a constant reminder that his willingness to pay for an ABC publication is the acid test of its value both to him and to its advertisers.

McGraw-Hill Publishing Company

STANDARD HD
TRADE MARK
OIL

Running up record ring life with . . .

● In 1947, operators of a midwest municipal power plant put a new 1060-hp diesel unit into service, using STANDARD HD Oil for lubrication.

After 19,000 hours' operation, the unit was shut down for inspection. The engine was entirely free from deposits and showed minimum wear. Piston rings were in excellent condition and were replaced in the engine for further service. This unit is still going strong with a total of 23,000 hours of trouble-free operation on its original piston rings.

Installed in 1950, a 1755-hp, supercharged diesel engine in this plant is running up another record for low maintenance with STANDARD HD. After more than 9,000 hours' operation, this unit was inspected and found unusually clean. Rings were free, and it was not necessary to remove them for cleaning purposes.

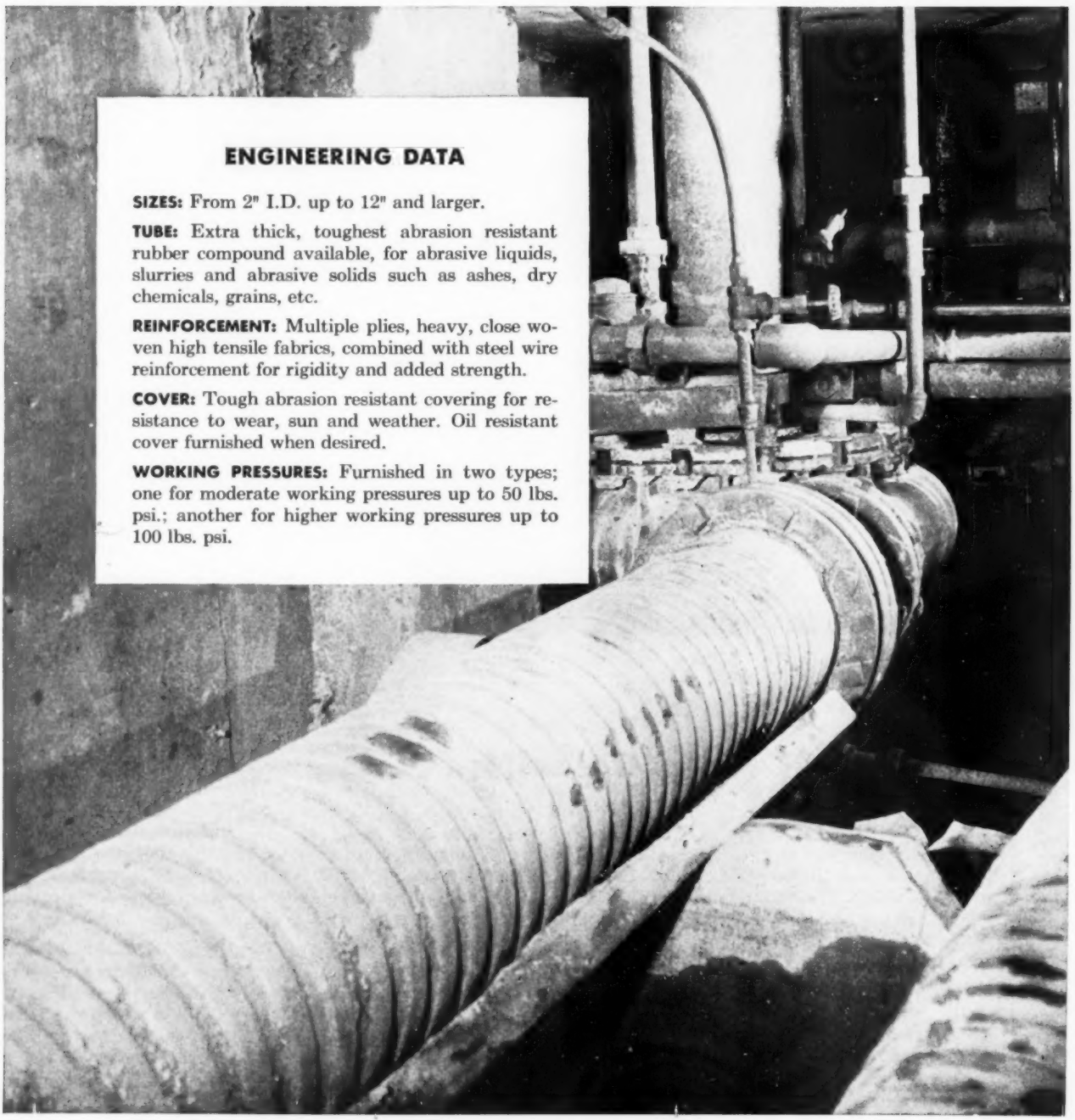
The outstanding performance of STANDARD HD Oil in all types of diesel-generating installations provides the evidence of the benefits it can bring in your diesel units. The Standard Oil lubrication specialist serving your immediate area of the Midwest will be glad to give you this evidence, using plants with which you may be familiar. Phone your local Standard Oil office. Or write: Standard Oil Co., 910 S. Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY

STANDARD

(Indiana)

Forecasts 5-Year Life



ENGINEERING DATA

SIZES: From 2" I.D. up to 12" and larger.

TUBE: Extra thick, toughest abrasion resistant rubber compound available, for abrasive liquids, slurries and abrasive solids such as ashes, dry chemicals, grains, etc.

REINFORCEMENT: Multiple plies, heavy, close woven high tensile fabrics, combined with steel wire reinforcement for rigidity and added strength.

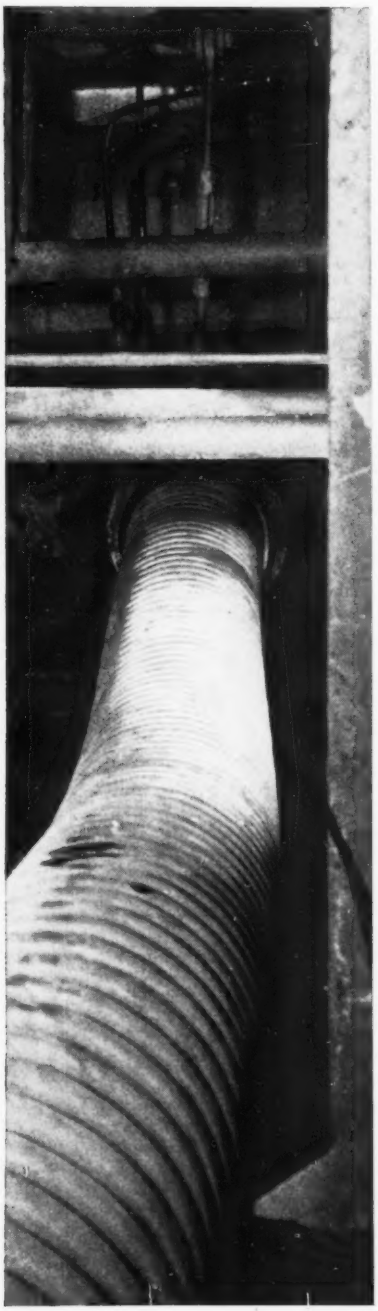
COVER: Tough abrasion resistant covering for resistance to wear, sun and weather. Oil resistant cover furnished when desired.

WORKING PRESSURES: Furnished in two types; one for moderate working pressures up to 50 lbs. psi.; another for higher working pressures up to 100 lbs. psi.

HEWITT-ROBINS

EXECUTIVE OFFICES, STAMFORD, CONNECTICUT

in Slag Disposal Line



Customer's Performance Record

EQUIPMENT: Hewitt-Robins Flexible Rubber Pipe.

LOCATION: Philadelphia Electric Company, Richmond Generating Station, Philadelphia, Pennsylvania.

OPERATION: Disposal of slag and pyrites from two boilers in generating plant.

PERFORMANCE: The projected life of a test length of Flexible Rubber Pipe, originally installed in a line handling fly ash, was 8 to 10 years on straight runs and 5 to 6 years on bends—*double the life* of metal pipe in the same line.

Since the test length was installed the line has been changed considerably. It now handles highly abrasive pyrites and slag instead of fly ash, although the volume is the same. Based upon 3 years performance, the projected life of this new line, consisting entirely of Hewitt-Robins Flexible Rubber Pipe, is at least 5 years—a remarkable life expectancy, considering the extremely abrasive material being handled.

RESULTS: Hewitt-Robins Flexible Rubber Pipe is replacing existing metal pipe installations for this operation at other stations in the Philadelphia Electric Company.

CHECK FOR INFORMATION ABOUT THESE JOB-TESTED PRODUCTS FOR YOUR OPERATION

CONVEYORS:
- ☐ —Belt
- ☐ —Dock
- ☐ —Sectional
- ☐ —Vibrating

BELTING:
- *☐ —Elevator
- *☐ —General
- *☐ —Rayon
- ☐ —Woven Wire
- ☐ BUCKET ELEVATORS
- ☐ IDLERS

SCREEN CLOTH:
- ☐ —Electrically Heated
- ☐ —General
- ☐ VIBRATING SCREENS

HOSE:
- *☐ —Air
- *☐ —Fire
- *☐ —Flexible Rubber Pipe
- *☐ —Pinch Valve
- *☐ —Servall®
- *☐ —Steam
- *☐ —Twin-Weld®
- *☐ —Water
- ☐ MECHANICAL FEEDERS
- ☐ STACKERS
- ☐ CAR SHAKEOUTS

TRIPPERS:
- ☐ —General
- ☐ —Dust Seal
- ☐ BELT CLEANERS
- ☐ CRUSHERS
- ☐ STOCKING & RECLAIMING SYSTEMS
- ☐ DESIGN AND CONSTRUCTION OF COMPLETE MATERIALS HANDLING SYSTEMS

*For immediate information about these industrial rubber products, call your Hewitt Rubber Distributor (See "Rubber Products" Classified Phone Book.)

Hewitt-Robins Incorporated
666 Glenbrook Road
Stamford, Connecticut

NAME

TITLE & COMPANY

STREET ADDRESS

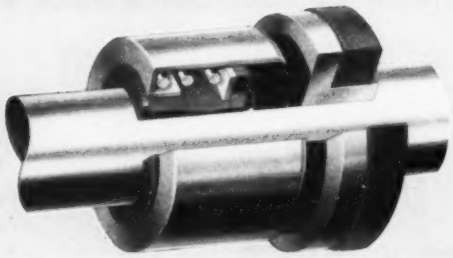
CITY PO ZONE STATE

770

INCORPORATED

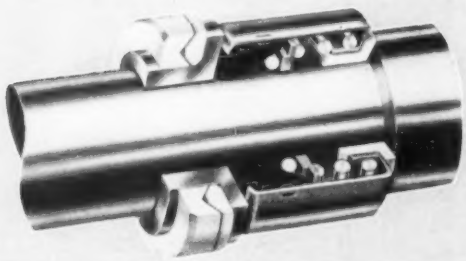
DOMESTIC DIVISIONS: Hewitt Rubber • Robins Conveyors • Robins Engineers • Restfoam
FOREIGN SUBSIDIARIES: Hewitt-Robins (Canada) Ltd., Montreal • Hewitt-Robins Internationale, Paris, France • Robins Conveyors (S. A.) Ltd., Johannesburg • **EXPORT DEPARTMENT:** New York City.

Garlock "Package" Seals
FOR ROTATING PUMP SHAFTS



Type BB-21A—Garlock Package Seal of standard construction with brass shell, brass washer, and Buna-N bellows.

	TYPE BB-21A	TYPE AA-21A
Liquids	For water, oils, alcohol, solvents (except aromatic, chlorinated and ketone types) and other liquids (except strong acids).	For very strong acids, oils, solvents (including aromatic, chlorinated and ketone types) and all other liquids.
Equipment	Rotating shafts of centrifugal pumps, process pumps, chemical pumps, agitators and similar applications.	
Sizes	For shafts from ⅜" to 3" diameters.	
Temperatures	With Buna-N bellows up to 212°; with silicone bellows up to 450° F.	Up to 450° F.
Pressures	Up to 150 p.s.i.	Up to 150 p.s.i.



Type AA-21A—Garlock Package Seal with hat-shaped "Teflon" drive ring, brass or 316 stainless steel shell and washer, "Teflon" 'O' ring, and "Teflon" two-piece vibration ring.

✓ CHECK THESE IMPORTANT FEATURES

- ☐ Occupy very small space
- ☐ Completely assembled—ready to install
- ☐ Proven performance at low cost
- ☐ Both types are dimensionally interchangeable

In both of these Package Seals, a leakless seal is provided by a positive contact between carefully lapped metal-to-carbon mating surfaces. All metal parts in both types are available in plated-brass, Ni-Resist, stainless steel with malcomized face, Garlock "B" iron, and others.

For complete details, ask your Garlock representative or write us about your sealing problems.

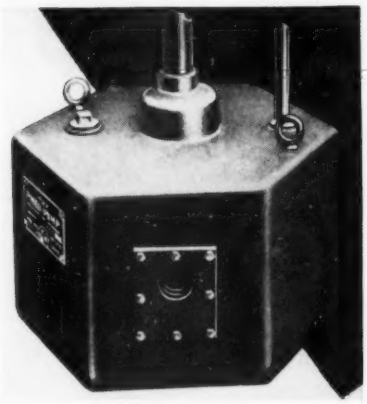
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.
Branch Offices in Most Principal Cities

GARLOCK

PACKINGS, GASKETS, OIL SEALS,
MECHANICAL SEALS,
RUBBER EXPANSION JOINTS

More EQUIPMENT NEWS

Begins on page 176



Pneumatic Ejector

1052 • Low-volume pneumatic ejector handles acids, mud, oils, sludges, water, etc. Unit has only one moving part, a ball inlet valve, and can be operated from existing air supply. Manufacturer claims *Pneu-Pump* will handle liquids near the boiling point. Available with cast-iron, lead-lined, rubber-lined or stoneware body.
Yeomans Bros Co, 2002-2 N Ruby St, Melrose Park, Illinois

For more data on these items, use post cards p 185. Identify your request with item number.

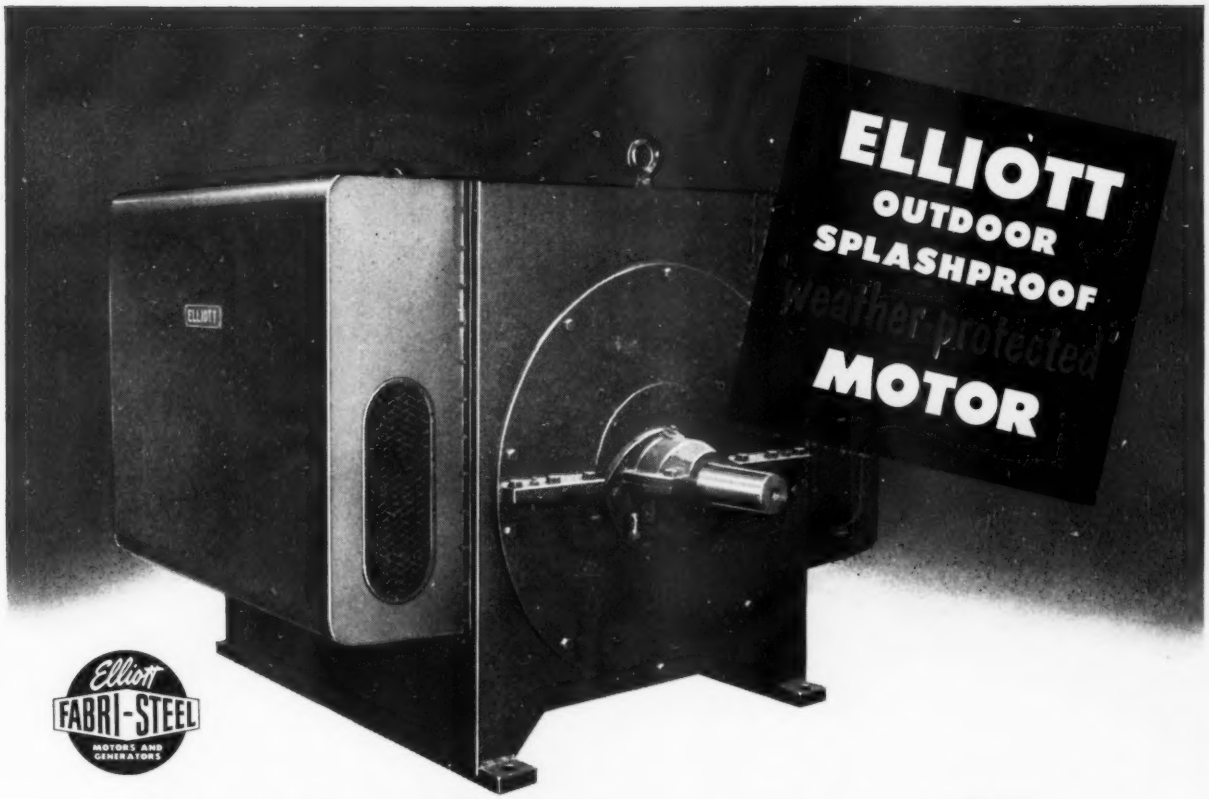
Butane-Propane Hose

1019 • New type butane hose features non-porous oil resistant rubber tube for handling liquified petroleum gases. Combined layers of braided steel wire and rayon cord provide minimum burst strength of 1750 psi. Each length has two separate static wires interlaced with reinforcing braids to insure full static conductivity.
Quaker Rubber Corp, Philadelphia, Pennsylvania

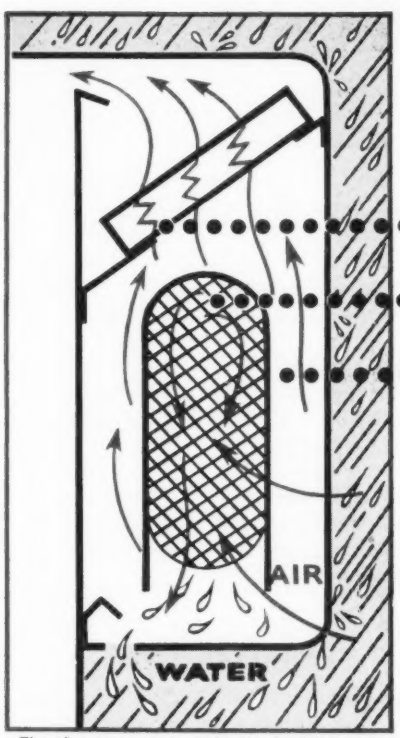
Foam Eductor

1053 • Unit introduces foam-forming liquid into fire hose line to provide mixture of foam and water for operating manufacturer's type *FFF FogFoam* nozzle. The eductor may be used anywhere in the run of hose. Pickup tube incorporates a ball check valve to prevent flow of water to foam container when nozzle is shut off. Available in four models in 1½ and 2½ in. sizes.
Rockwood Sprinkler Co, 38 Harlow St, Worcester 5, Massachusetts

(*Continued on page* 198)



Here's what we mean by "weather-protected"



The above arrangement is standard. However where dust or flying dirt is not a factor, motor can be supplied without the air filter, but with screens and baffles only.

This splashproof motor says "keep out" to everything but air. That means dust, rain, snow, dead leaves, warmth-seeking rodents, snakes, nesting birds and what-not. And here's why:

THE AIR FILTER stops dust, snow, or traces of moisture that may have reached up as far as the filter.

THE AIR INTAKE SCREEN keeps out debris, flying leaves, and small animal life.

THE INVERTED "U" BAFFLE makes all incoming air and airborne moisture go *down* before it can go up, using multiple air reversals and velocity changes to throw off the moisture. That's where moisture says "good-by" and departs through the drainage slot. The construction is in effect an efficient water separator.

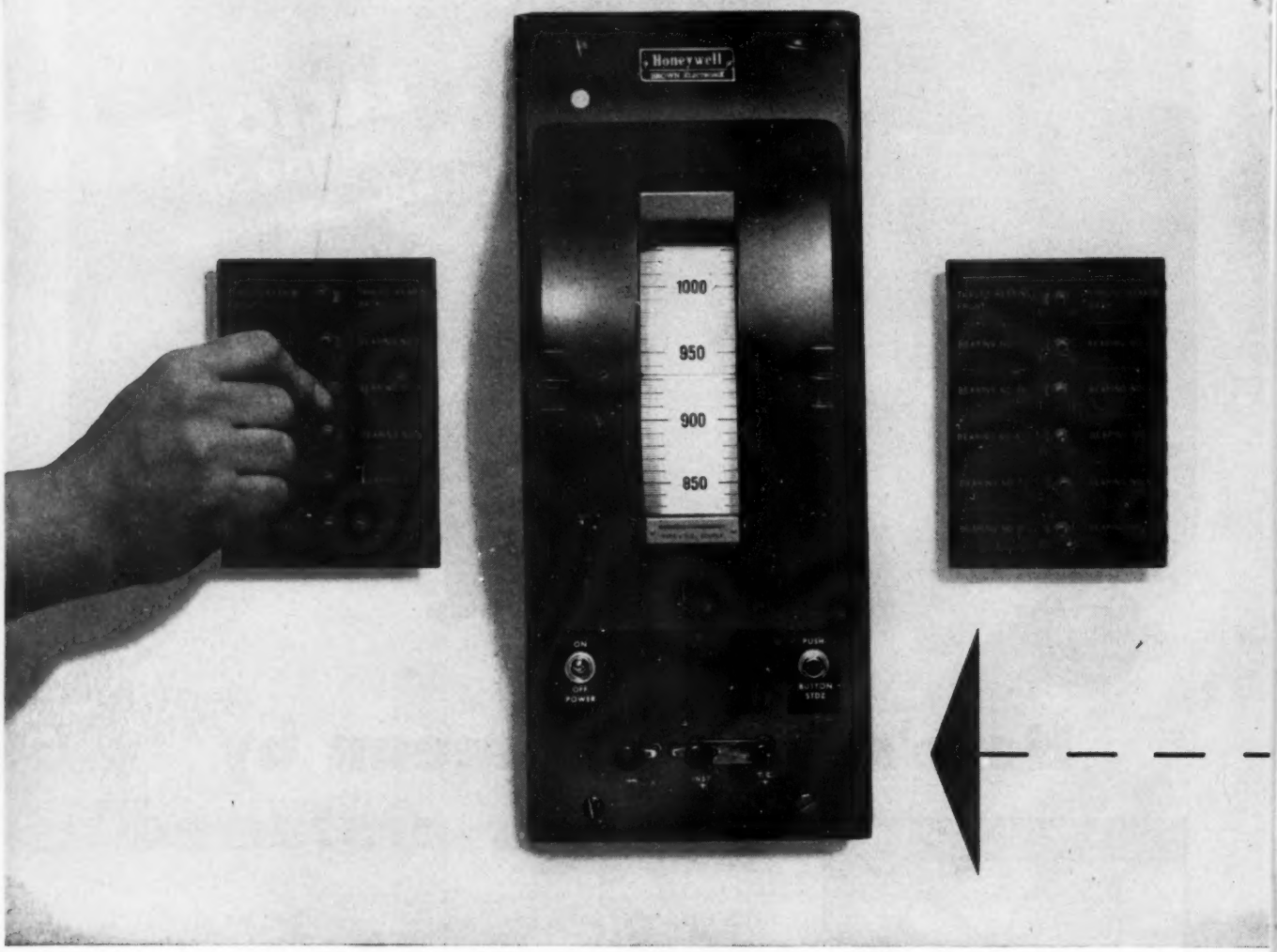
Whatever your weather, you can put this motor out in it, just on a plain slab — no cored foundation or other expensive complexity. Why not get the data—see your local Elliott engineer or write Elliott Company, Ridgway, Pa.

ELLIOTT Company

R3-15

RIDGWAY DIVISION

FOR MOTORS 1-200 HP: CROCKER WHEELER DIV. AMPERE, N. J.



Look at these features!

compact case
approximately 6½ inches wide by 15⅜ inches high

easily-read drum scale
rotates vertically; graduated length 28⅝ inches provides big, legible scale divisions and numerals.

accurate hairline index
eliminates parallax errors, permits high readability.

fast measurement
full scale rotation in 4½ or 12 seconds for 60-cycle operation.

external key switches
can be located at the side of the indicator (as shown), below or above—wherever most convenient for the particular panel layout.

large number of points
additional key switch banks provide any desired number of temperature points. Legend plates facilitate identification.

high precision
calibrated accuracy is 0.2% of scale span.

variety of ranges
supplied for use with either thermocouples or resistance thermometers, in a selection of ranges applicable to power plant temperatures.

Squeezed for panel space?

THIS NEW

Honeywell temperature indicator

needs no elbow room!

CROWDED PANELS are no problem for this new temperature instrument . . . the Vertical Scale Precision Indicator. Its slender, compact case makes it a natural for graphic panels—and a readily-inserted, space-saving member of conventional generator and turbine boards.

Basically, it's the same *ElectroniK* Precision Indicator which the power industry and many others have used and relied upon for many years. But, its outside appearance has changed: it's a completely new design that places the bulk of the instrument mechanism *behind* the panel . . . uses the valuable front-of-panel space primarily for the indicating scale.

Equipped with key switch banks, the Vertical Scale Precision Indicator offers a fast, convenient way to spot-check temperatures in bearings, pumps, hydraulic couplings, motors and other potential hot spots.

Your local Honeywell engineering representative will be glad to discuss how this new instrument can save space on the new panels which you may be planning. Call him today . . . he is as near as your phone.

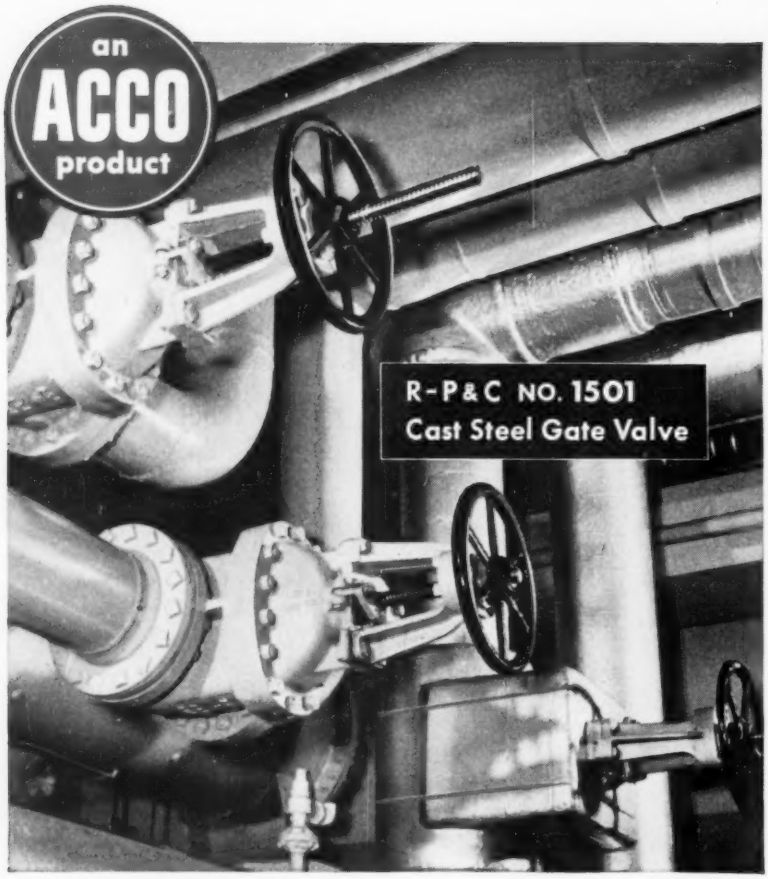
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4490 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA: Write for new Bulletin No. 1541 on the Vertical Scale Precision Indicator.**

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls



How R-P&C Valves Reduce Maintenance Costs

• Six important features of R-P&C Cast Steel Valves eliminate many service troubles which in turn reduces maintenance costs.

First of all . . . they're made from electric furnace steel which means sound castings. All parts are designed for equal strength and great toughness. The bodies resist distortion. Permanent alignment is provided by the rigid one-piece yoke. And the gland packing stays tight even at high pressures and temperatures. Furthermore, the design detail assures smooth flow and positive shut-off.

You can get R-P&C Cast Steel Valves in gate, globe, angle, stop and check, and swing check types. Variety of trim metals for air, gas, liquid, oil, steam, water. Wide range of pressures and temperatures. Screwed, flanged, or welding ends. Sizes range from 1½" to 24".

Specify . . . and *get* . . . R-P&C Cast Steel Valves next time you order.

ACCO

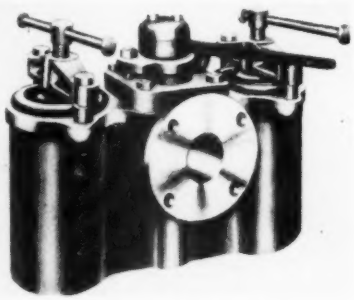
R-P&C VALVE DIVISION
AMERICAN CHAIN & CABLE

Reading, Pa., Atlanta, Baltimore, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

R-P&C valves

More EQUIPMENT NEWS

Begins on page 176



Duplex Strainers

1054 • *Duoflo* duplex strainers can be used on either suction or pressure liquid lines that have a continuous flow. The strainer uses two removable baskets, each contained in a separate straining compartment with removable cover. Liquid flows through one basket while flow through other is shut off. But valve does not shut off flow.

Units are available for working pressures up to 150, 300, 500 and 1500 psi. Pipe diameters range up to 12 in., with maximum capacity of approximately 5 million gpd. Bulletin 200.

Sheffler-Gross Co, Drexel Bldg, Philadelphia 6, Pennsylvania

Flow Rate Meter

1055 • *Tel-Flo* meter is suitable for measuring flow rates and purging line. Case is aluminum with plastic front, can be furnished with any type of metal body. Maximum pressure is 300 lb, with higher pressures on request.

Uehling Instrument Co, 473 Getty Ave, Paterson, New Jersey

For more data on these items, use post cards p 185. Identify your request with item number.

Chemical Pumps

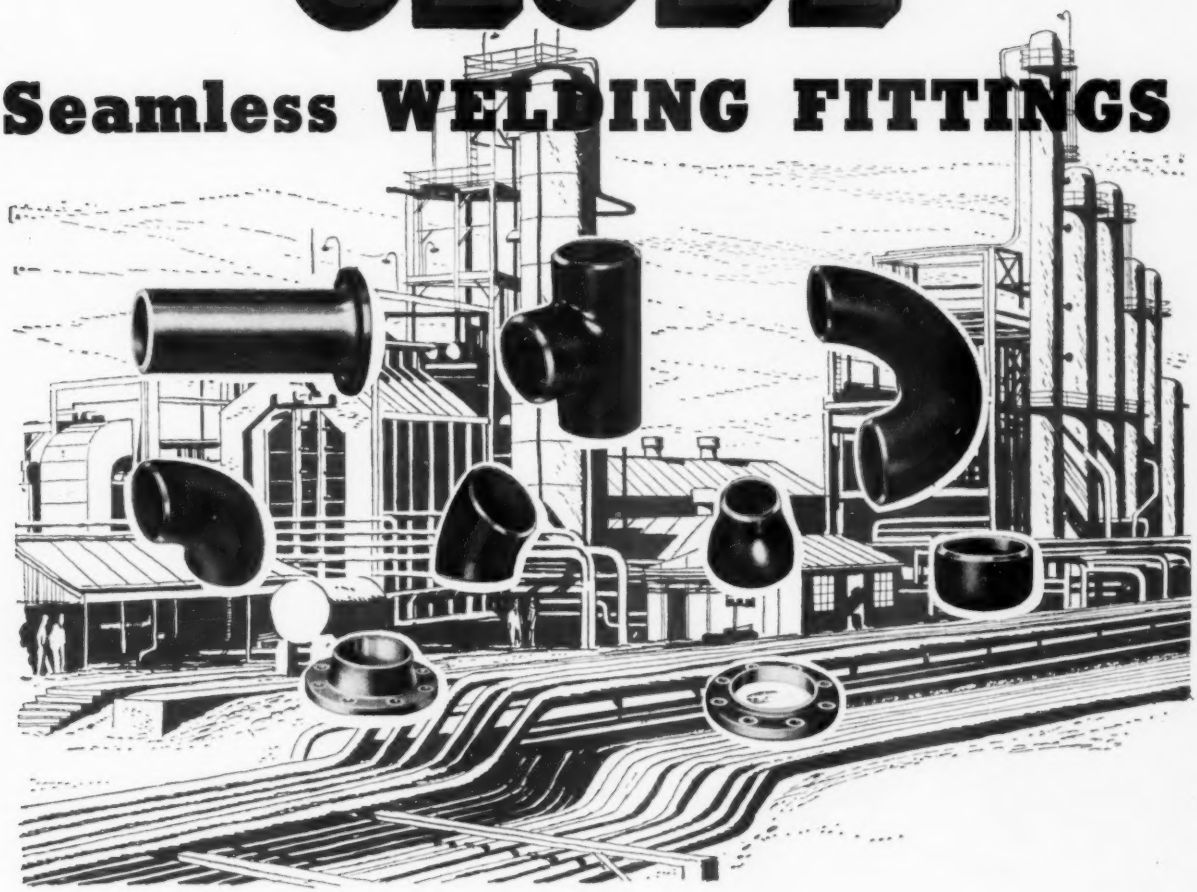
1056 • New PXHB series pumps use Buna N hard rubber body block for withstanding temperatures up to 225 F, as well as the corrosive effect of many acids, caustics and organic solvents, manufacturer claims.

Pump is activated by an eccentric rotor

(*Continued on page 202*)

GLOBE

Seamless WELDING FITTINGS



The only seamless welding fittings precision-processed . . . from billet . . . to tube . . . to fitting

From charging the specially designed revolving furnace with a steel billet (above) through the many succeeding steps of production, every Globe process is specialized to produce fittings of unvarying quality.

Globe precision-process manufacture begins with the billet —continues through the making of the seamless steel tube (Globe alone among welding fittings manufacturers produces seamless steel tubes)—and extends through to the production of the finished fittings.

Because Globe has highly specialized controls—at every stage of manufacture at its own plant—you can be sure of uniform high quality seamless welding fittings when you specify Globe.

Send for the Globe Welding Fittings complete catalog.

GLOBE STEEL TUBES CO.,
Milwaukee 46, Wisconsin

Chicago • Cleveland • Detroit • New York • Philadelphia • St. Louis • Denver • Houston • San Francisco
Glendale, Cal.

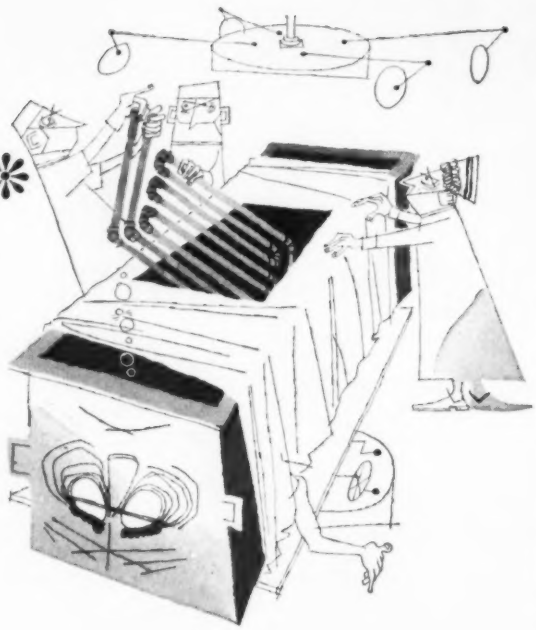
Producers of Globe Welding Fittings — Globe seamless stainless steel tubes — alloy-carbon seamless steel tubes — Gloweld welded stainless steel tubes — Globeiron (high purity ingot iron) seamless tubes.

AVAILABLE IN A COMPLETE LINE OF SIZES AND WEIGHTS THROUGH GLOBE DISTRIBUTORS IN ALL KEY CITIES

has

coil-itis ✻

got you constantly doctoring your tanks?



Like the human appendix, pipe coils often give constant trouble until they are removed and replaced with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster. They take 50% less space in the tank leaving room for greater payload. Platecoils overcome the limitations and operating difficulties of old fashioned and outmoded pipe coils to save hours of downtime.

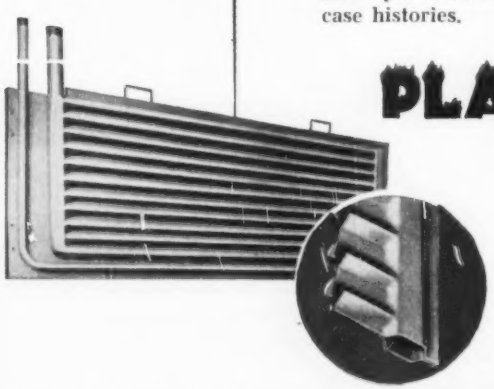
It costs less to cure coil-itis with Platecoils than to suffer its evils.

Write for Bulletin P79 today!

PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS

PLATECOILS REQUIRE 90% LESS CLEANING

At Motor Wheel Corporation cleaning time has been cut from 10 hours per pipe coil every 60 days to only one hour per Platecoil. Ask about other case histories.



PLATECOIL

REPLACES PIPE COILS

✻

Coil-itis — Diagnosed as tank heating and cooling problems. Platecoils — the prescription for solving pipe coil problems.

PLATECOIL DIVISION, TRANTER MANUFACTURING, inc., LANSING 4, MICHIGAN

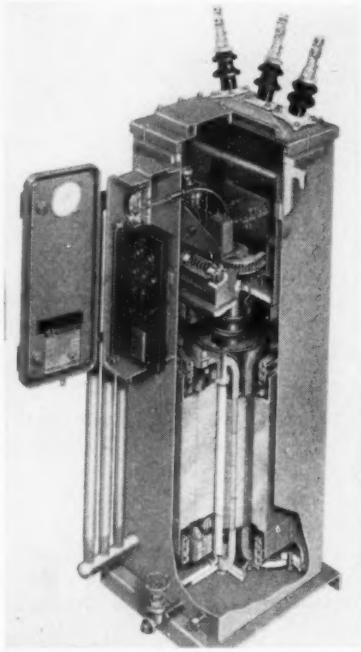
More EQUIPMENT NEWS

Begins on page 176

and shaft assembly that rides inside a flexible liner. Fluid is progressively "squeezed" through pump between liner and inner surface of the body block.

Capacities range from 1/3 to 20 gpm, with pressure range from 0 to 60 psi. All units are self-priming with lifts up to 24 in. Hg.

Vanton Pump Co, Empire State Bldg, New York, N. Y.

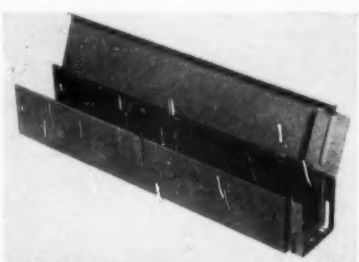


Voltage Regulator

1032 • Type SU induction voltage regulator is now lighter, smaller, simpler to maintain. Mechanical control adjustments have been eliminated and new relay requires no pivot or guide bearings. Relays are mounted on back of a swinging panel. Vertical terminal board has connections for either series or parallel operation of secondary winding.

Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

For more data on these items, use post cards p 185. Identify your request with item number.



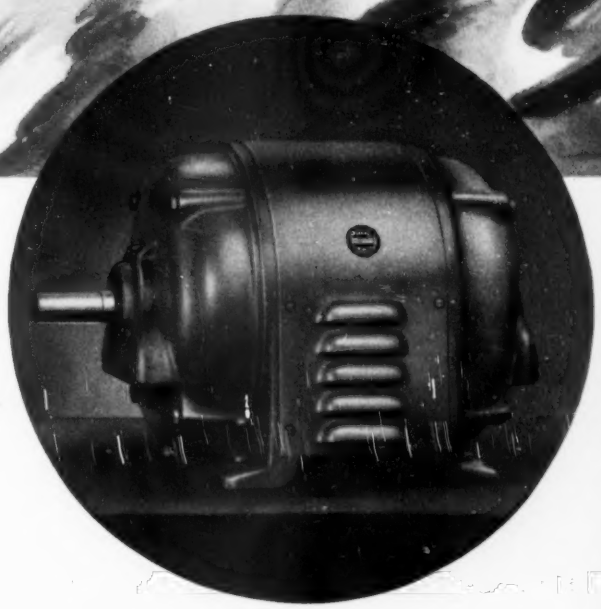
Wiring Trough

1057 • *Lay-In* duct is hinged to provide an unobstructed wireway to lay in conduc-

(*Continued on page 208*)

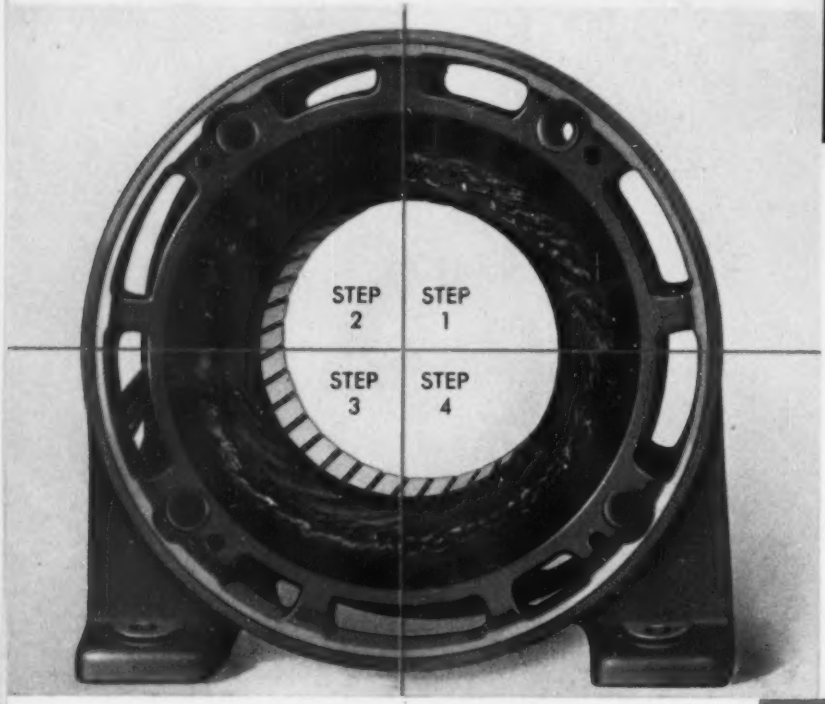
ASBESTOS-PROTECTED !

Asbestos cannot carbonize. That's why all U. S. Motors are asbestos-protected. Life of a motor is proportional to the life of the insulation protecting its windings. In U. S. Motors wires are insulated with asbestos to forever protect them against heat. The exclusive process of insulating U. S. Motors with asbestos insures years of extra motor life- and protection against burn-outs.



U. S. MOTORS ASBESTOS-PROTECTED

Avoid this...



INSTALL U.S. ASBESTOS PROTECTED MOTORS

WINDINGS GIVEN MULTIPLE TREATMENT

Step by step, everlasting endurance is built into every U.S. motor by use of asbestos, the only natural fibrous element that cannot carbonize. Four progressive treatments of asbestic compounds are applied plus oven-baking, as follows:

STEP 1 — Synthetic insulated wire wound into coils and inserted in slots lined with sheet asbestos.

STEP 2 — Complete stator is submerged in liquid asbestos insulating compound while pulsating current vibrates wires; then baked. A second dip and further baking follows.

STEP 3 — Plastic asbestos compound is sprayed between and over all end turns, then baked to harden throughout.

STEP 4 — Final spray seals pores; after fourth bake the surface contour is smooth.

U. S. ASBESTIC PROCESS

(A)—Empty stator slot before insulating and winding. (B)—Formed coil of asbestos providing a heat-proof wall of insulation. (C)—Cross section showing wires inserted, with asbestos coil covering entire winding. Asbestos plateboard in center of slot separating and insulating between coils. (D) Asbestosite (in color) forced around windings, penetrates every interstice.

U. S. Electrical Motors Inc.
Box 2058, Los Angeles 54, Calif. or Milford, Conn.
Send your new Bulletin illustrating and describing U. S. Asbestos-Protected Motors. ☐ Also General Bulletin. ☐

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

U.S. ELECTRICAL MOTORS, Inc.

PACIFIC PLANT: Los Angeles 54, Calif. **ATLANTIC PLANT: Milford, Conn.**

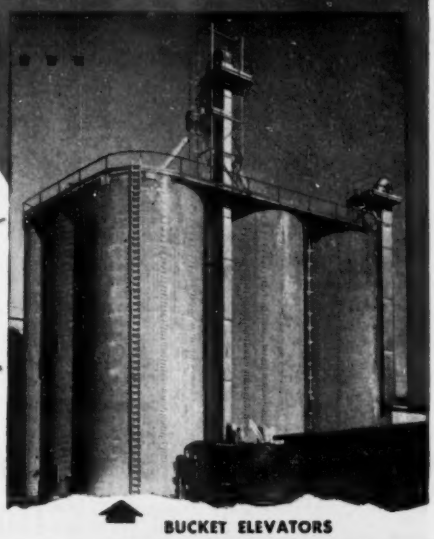
Atlanta 3, Ga.; Bakersfield, Calif.; Boston 16, Mass.; Chicago 8, Ill.; Cincinnati 16, Ohio; Cleveland 14, Ohio; Dallas 9, Texas; Detroit 2, Mich.; Fresno 1, Calif.; Houston 4, Texas; Indianapolis 4, Ind.; Milwaukee 2, Wisc.; Minneapolis 2, Minn.; New York City 6, N. Y.; Philadelphia 2, Pa.; Pittsburgh 2, Pa.; San Francisco 7, Calif.; Seattle 4, Wash.
Sales and Service offices in all principal cities.

US MOTORS

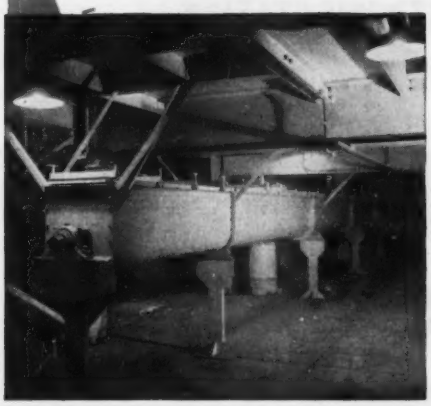
one unit or a complete system . . .

TO SPEED PRODUCTION

around the clock



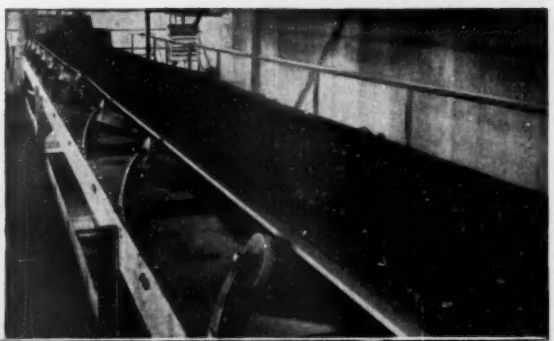
BUCKET ELEVATORS

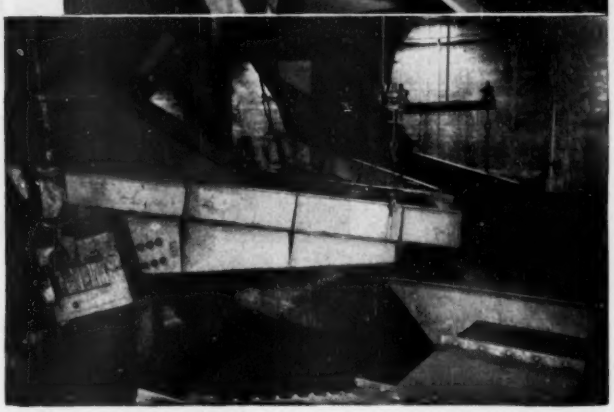


BELT CONVEYORS

SPIRAL CONVEYORS

FEEDERS





Efficient, fast, low-cost production (24-hour service if need be) calls for adapting the right unit or units to each individual job. Since Jeffrey builds so many kinds of handling devices, isn't it logical to rely upon the recommendations of our Engineers?

Whether it's conveying, elevating, feeding, drying, cooling, crushing or pulverizing, packing or transmitting power . . . Jeffrey can provide the right unit—or complete system—with a working knowledge based on 75 years of experience and scores of installations. What is your materials-handling or processing problem?

THE JEFFREY MANUFACTURING CO.

ESTABLISHED 1877

Columbus 16, Ohio

sales offices and distributors in principal cities

PLANTS IN CANADA, ENGLAND, SOUTH AFRICA

IF IT'S MINED, PROCESSED OR MOVED

. . . IT'S A JOB FOR JEFFREY!

FOR MAXIMUM RETURN ON YOUR COMBUSTION CONTROL AND INSTRUMENTATION DOLLARS, THE SYSTEM MUST BE . . .

ACCURATE
DEPENDABLE
VERSATILE

. . . THE BASIC CHARACTERISTICS OF

HAGAN

AUTOMATIC COMBUSTION CONTROLS AND RING BALANCE INSTRUMENTS

ACCURATE Inherent accuracy is one of the outstanding characteristics of Hagan Automatic control systems. Such accuracy results from a basic Hagan policy, which requires that each component be designed to optimum operating efficiency. To make the fullest use of accuracy, the second basic requirement is that Hagan equipment must be . . .

DEPENDABLE This is assured by the sound, sturdy construction of all Hagan components. Hagan engineers are familiar with the problems of field operation. This knowledge is brought to bear on the design. As a result, Hagan equipment is still operating efficiently in many steam plants built twenty or thirty years ago. The third basic guide for Hagan design is that each component must be . . .

VERSATILE Every unit in the Hagan System of Combustion Control and Instrumentation is integrated with the rest. This means that, whatever the requirements of your plant, in terms of number and size of boilers, combinations of fuel, load fluctuations or pressure conditions, a system can be tailor-made to fit exactly. Accurate—Dependable—Versatile—Hagan Combustion Control and Instrumentation assure optimum operating efficiency for your plant.

Let Hagan engineers help you solve your control and instrumentation problems. They can make available to you the experience gathered from thousands of successful installations.

HAGAN HALL BUROMIN CALGON

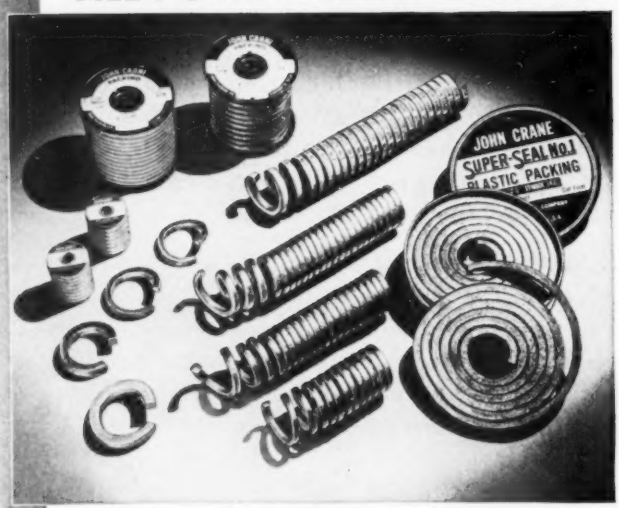
HAGAN CORPORATION

HAGAN BUILDING • PITTSBURGH 30, PENNSYLVANIA

BOILER COMBUSTION CONTROL SYSTEMS • RING BALANCE FLOW AND PRESSURE INSTRUMENTS • METALLURGICAL FURNACE CONTROL SYSTEMS CONTROL SYSTEMS FOR AUTOMOTIVE AND AERONAUTICAL TESTING FACILITIES

Check with JOHN CRANE

TO GET THE RIGHT PACKING for ALL POWER PLANT SERVICES



Check your problem. It may be in the handling of boiler feed water . . . saturated or superheated steam . . . condensate . . . drain water . . . refrigerants.

Check "John Crane's" complete line of packings for the power plant. You'll find that "John Crane" engineers have designed and developed a particular type of packing to meet your individual applications or service condition.

Check "John Crane" for types and sizes. You'll find an exceptionally wide range of metallic, semi-metallic, plastic, fabric and Teflon* packings . . . spirals, coils, sheets and die-formed rings and sets to fit all stuffing boxes.

Check "John Crane" for quality and availability. Only the finest materials, binders and lubricants are used, forming a resilient, flexible, non-frictional strong packing. Completely stocked warehouses throughout United States and Canada give you prompt service in the quantity you need.

Check with "John Crane" engineers for recommendations and assistance you need for handling even your most difficult applications. Send for fully illustrated catalogs. Crane Packing Company, Cuyler Ave., Chicago 13, Illinois.

*Du Pont trademark for tetrafluoroethylene resin.

JOHN CRANE
CRANE PACKING COMPANY

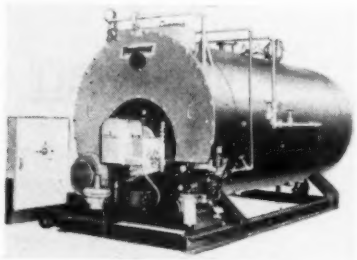
More EQUIPMENT NEWS

Begins on page 176

tors. Installation time is said to be reduced as much as 20% since threading or pulling conductors is eliminated.

Available in standard sections in 2½x 2½, 4x4 and 6x6 in. Complete line of fittings with removable covers is also available.

Square D Co, 6060 Rivard St, Detroit 11, Michigan



Boiler-burner Unit

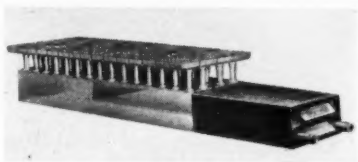
1012 • Boiler-burner unit for high or low pressure heating, power and process steam operates on oil, gas or oil-gas combination with rapid switching of fuels. Shipped as a packaged unit on steel skids, it is completely assembled for immediate operation.

Boiler is of ASME Code construction throughout and has unusually large furnace volume to insure lower heat release with longer service life. Fully automatic burner unit has turndown of 5 to 1 and will operate at over 80% efficiency through entire modulating range.

Power units cover capacity range from 37 hp to 363 hp at normal SBI ratings. Heating boilers are available in sizes from 4250 lb to 42,500 lb EDR at normal SBI steam rating. Bulletin available from manufacturer.

Titusville Iron Works Co, Titusville, Pa.

For more data on these items, use post cards p 185. Identify your request with item number.



Gas Burners

1058 • New series of commercial gas burners is available in stock sizes from 450,000 to 11,520,000 Btu input or more. Unit is a multiple-section upshot burner, installed through the ash pit door. Individual Venturi mixing tubes for each burner head assure uniform mixture to all parts of the burning area, manufacturer claims. Primary air entrainment is high, and adjustment is provided for various types of fuel gas. No refractory combustion chamber liner is used. Burner is step-acting and modulated so various sections come on in sequence instead of all at once.

Petro Automatic Heating & Power Equipment, 3170 W 106th St., Cleveland 11, Ohio

Original and Genuine

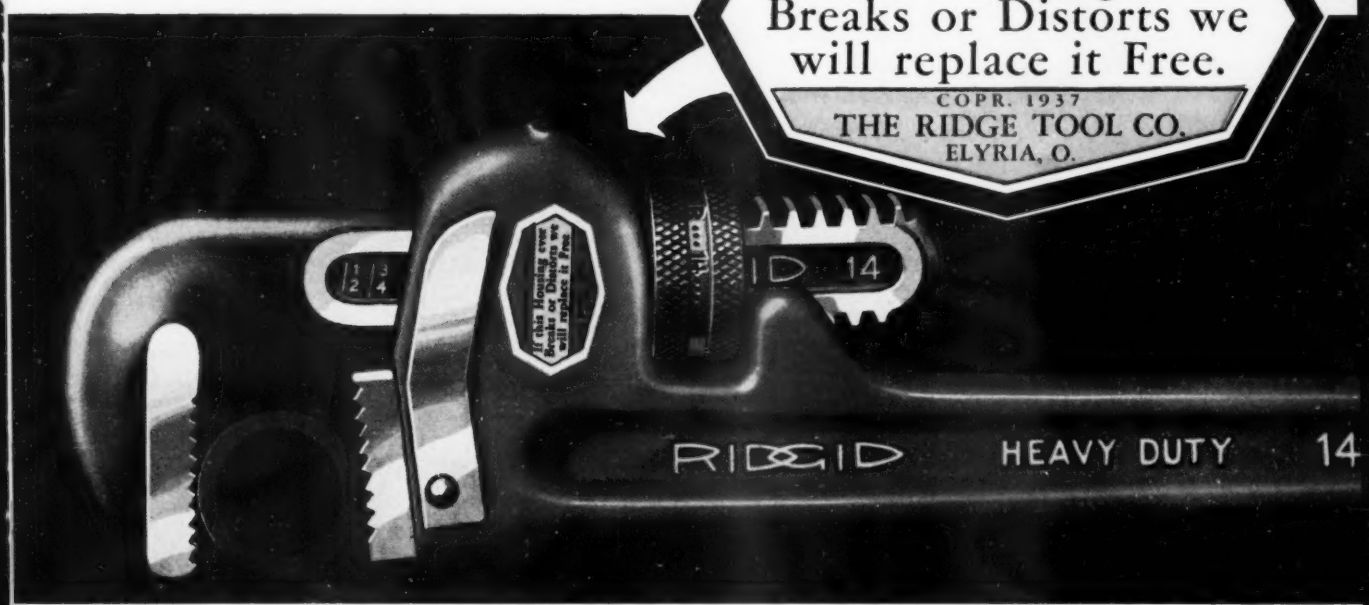
RIDGID

HEAVY-DUTY PIPE WRENCH

Read this guarantee —on millions of RIDGID wrenches sold to date.

1st with guaranteed housing—
still the only one!

★
UNCONDITIONAL GUARANTEE
If this Housing ever Breaks or Distorts we will replace it Free.
COPR. 1937
THE RIDGE TOOL CO.
ELYRIA, O.



1st *with replaceable jaws*—non-slip, non-lock, instant grip on pipe.

1st *with adjusting nut in open housing*—always spins easily to pipe size, 6″ to 60″.

1st *with handy pipe scale* on hookjaw.

1st *with comfort-grip I-beam handle*—with handy hang-up hole.

1st *with end pattern pipe wrench*—for pipes crowded or against flat surfaces.

No wonder RIDGID is the world's most popular pipe wrench. Buy genuine RIDGID's for easier work and extra economy—at your supply house.

THE RIDGE TOOL COMPANY, ELYRIA, OHIO, U. S. A.

RIDGID

Work-Saver Pipe Tools··Most Popular in the World

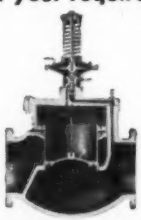
GOLDEN-ANDERSON

Cushioned

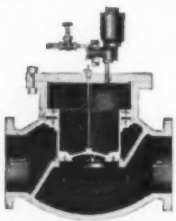
Steam and Water Pressure Valves

One of these eight valves will ideally meet your requirements

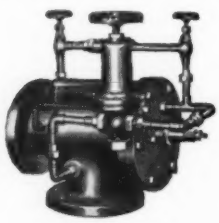
Single-Acting Non-Return Valve



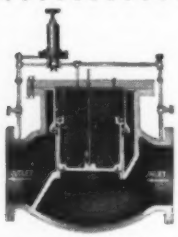
Altitude Control Valve



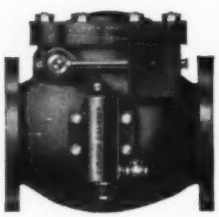
Solenoid Operated Electric Water Service Valve



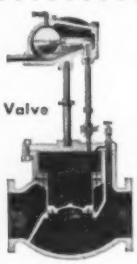
Surge Relief Valve



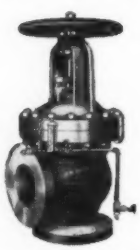
Water Pressure Reducing Valve



Swing Check Valve



Cold Water Float Valve



Triple-Acting Non-Return Valve

Our descriptive bulletins covering these various valves gladly sent on request.

GOLDEN ANDERSON Valve Specialty Company

2070 KEENAN BUILDING • PITTSBURGH 22, PA.

More EQUIPMENT NEWS

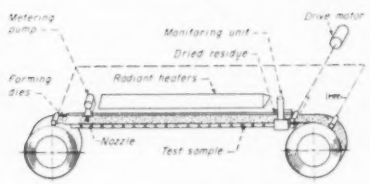
Begins on page 176

Safety Mask

1026 • Thirty-minute breathing apparatus is self-contained, weighs only 8½ lb and has a 5-minute safety cylinder that makes it unnecessary for user to keep track of oxygen supply. Unit can be recharged from standard oxygen cylinder and may be used as emergency inhalator. Same model, with two 5-minute cylinders, weighs only 4 lb.

Cycle-Flo Co, Milford, Conn.

For more data on these items, use post cards p 185. Identify your request with item number.



Automatic Continuous Sampler

1059 • Unit analyzes samples of liquids for radioactive material. Pump deposits metered sample in depression on tape, then water is evaporated, leaving solid residue for test.

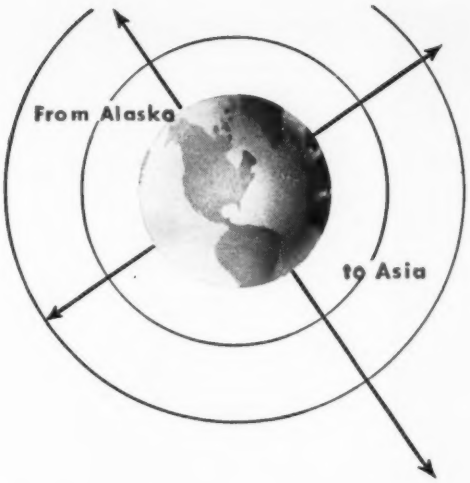
Possible applications include analyzing boiler feedwater; continuously monitoring concentration of liquid chemicals or pharmaceuticals; maintaining quality control on solid chemicals by liquefying crystals and measuring conductivity; sampling impurities in reactor cooling water to determine whether they are excessively radioactive.

American Machine & Fdry Co, 625 Eighth Ave, New York 18, N. Y.

Light-Diffusing Louvers

1067 • *GrateLite* ceilings diffuse light through ⅜-in. translucent cubical facets, providing 45 degree lamp shielding. Light is said to be distributed softly and evenly throughout the room. Ceiling sections rest on inverted "T" rails suspended from the overhead. Bulletin available.

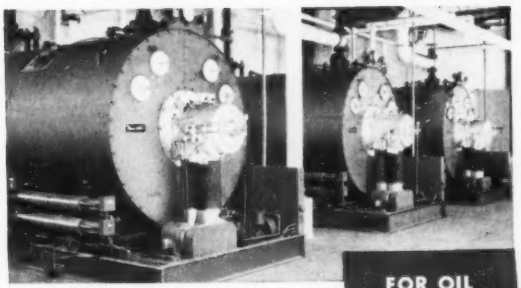
Edwin F Guth Co, 2615 Washington Blvd, St. Louis, Missouri



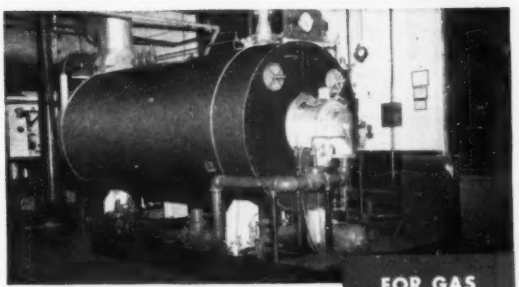
Powermaster®

is a world-wide choice for

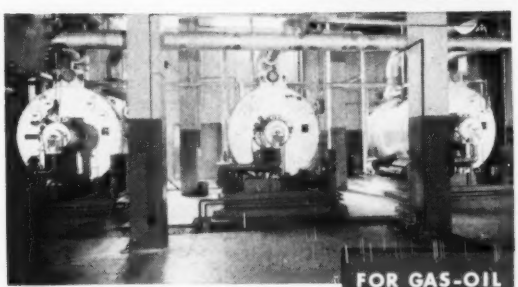
LOW-COST STEAM



FOR OIL FIRING



FOR GAS FIRING



FOR GAS-OIL FIRING

All over America—in U.S. Possessions . . . in Canada . . . South America . . . Europe . . . Asia . . . Africa—thousands of *Powermaster* Packaged Automatic Boilers are now supplying steam and hot water requirements—with outstanding reliability and economy for:

bakeries • beverage plants • canners and food processors • chemical plants • dairies • dry cleaners • hospitals and institutions • hotels • apartment and office buildings • laundries • meat packers • public schools and colleges • tanneries • textile mills • tire and rubber companies • paper mills • railroad shops • manufacturing plants • and many other users.

A large percentage of present users have ordered additional *Powermaster* units . . . and the list of new *Powermaster* users is getting longer every day.

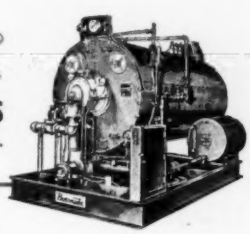
HERE'S WHY — Ease and economy of installation—space-saving compactness—fuel-saving smokeless VORIFLOW combustion—highly efficient operation at all loads—maintenance-saving accessibility—forced draft—full-range automatic modulating firing control—completely automatic operating and safety controls—these are some of the reasons for the steadily growing universal preference for *Powermaster.*

If selecting, installing, or operating boilers is your business, you'll want the complete story of Powermaster cost-saving advantages contained in this new bulletin.

Powermaster®

PACKAGED AUTOMATIC BOILERS

In sizes to 500 HP; pressures to 250 psi.



ORR & SEMBOWER, INC. • Established 1885 • **850 Morgantown Road, Reading, Penna.**

Sound Engineering

by

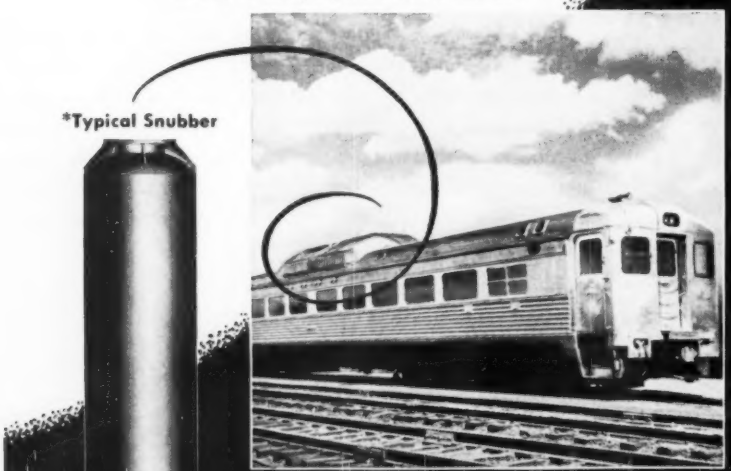
BURGESS-MANNING COMPANY

. . . wherever the flow of AIR, STEAM, and other GASES create N-O-I-S-E.

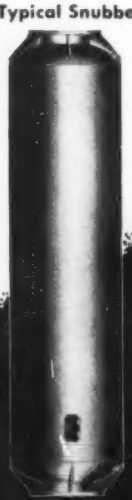
Standard Snubber* designs are available, incorporating Air Cleaning, Spark Arresting, Water Separation, Waste Heat Recovery, and Surge Control Features.

You can depend upon Burgess-Manning Engineers for a quality product . . . and SOUND ENGINEERING counsel to solve your noise problems.

Burgess-Manning Snubbers installed on The Budd Company RDC Diesel Rail Car.



*Typical Snubber



BURGESS-MANNING COMPANY

749-J East Park Avenue, LIBERTYVILLE, ILLINOIS

Chicago Dallas

More EQUIPMENT NEWS

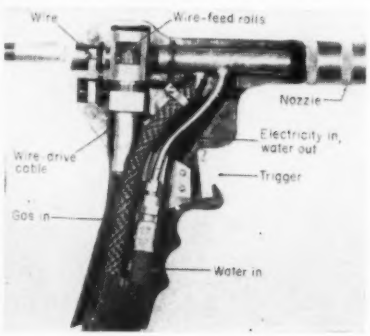
Begins on page 176

Ac Welder

1008 • Redesigned 300 and 500 amp ac welders feature one switch for changing range, another for turning off current at the welder between welds. Units are fan-ventilated.

Metal and Thermit Corp, 100 E 42nd St, New York 17, N. Y.

For more data on these items, use post cards p 185. Identify your request with item number.



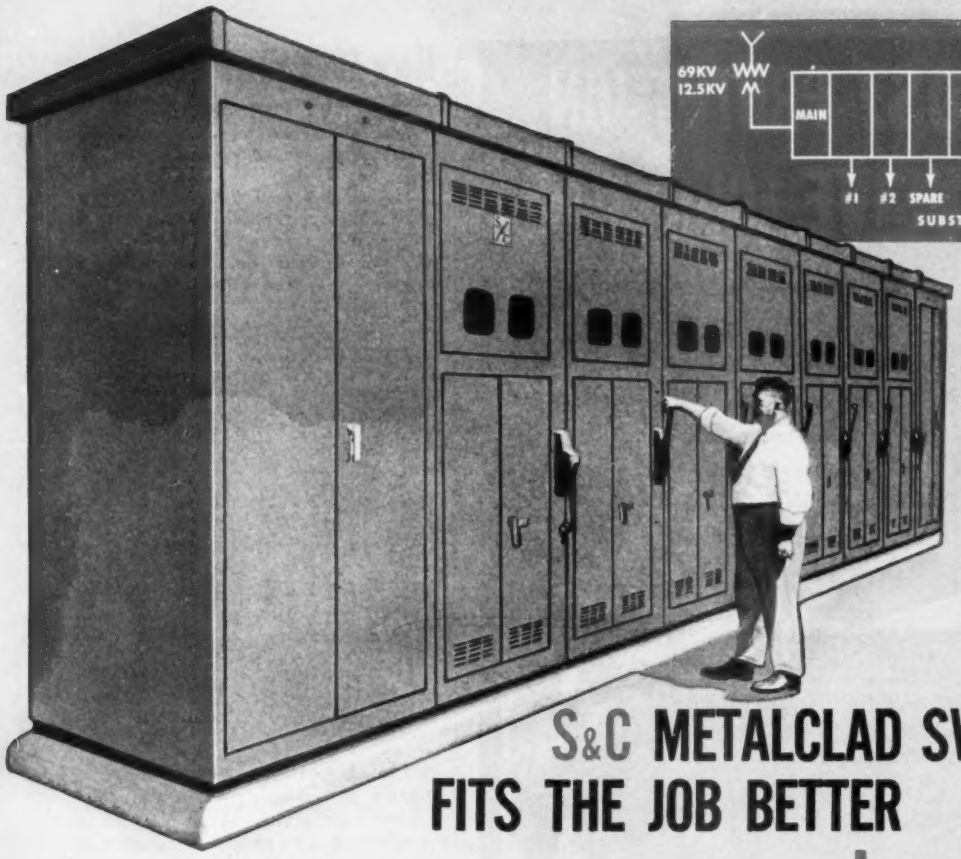
Welding Equipment

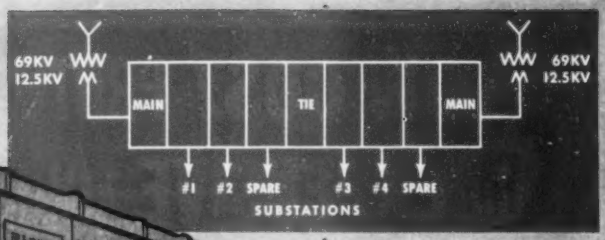
1014 • New equipment for consumable-electrode gas-shielded welding process enables operator to double output on jobs where filler metal must be added. Generator is rated at 450 a continuously with increasing voltage as current is produced by welder. Water-cooled gun unit has rating of 400 a continuous dc and can handle wire from .030 to .093-in. dia. Wire feed speed can be adjusted from 0 to 750 in. per min. Wire drive unit contains voltmeter for indicating wire feed speed as well as arc voltage, gas solenoid valve, control relays, and spindle for electrode wire.

General Electric Co, Schenectady 5, New York

Weld-Backing Compound

1060 • Silicone compound is said to permit greater welding flexibility by promoting uniform penetration and eliminating the harmful effects of air on the underside of welds. Manufacturer claims it is well suited





THIS S&C METALCLAD SWITCHGEAR

is part of Whirlpool's distribution system. Electric service is brought in at 69 KV. Two transformer banks deliver power at 12.5 KV to this double-ended switching center. Four feeders supply load centers which serve various areas of the plant with 440-volt power. Two additional feeders are spares for future use. A tie switch in the center bay, normally open, permits all feeders to be supplied from one transformer only under emergency conditions.

S&C METALCLAD SWITCHGEAR FITS THE JOB BETTER

...and it saves half the cost!

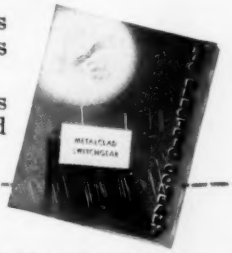
When Whirlpool Corporation recently acquired a plant in LaPorte, Ind., for the manufacture of aircraft parts, a new electric service had to be provided to meet the new requirements.

Koontz-Wagner Electric Co., Inc.—contractor-engineers of South Bend—were assigned to engineer and install the necessary equipment.

As part of the main substation, Koontz-Wagner selected S&C Metalclad Switchgear to provide fault protection and switching . . . because investigation showed it was not only adequate for every need, but that alternate equipment would have been larger and more cumbersome, required more ground area, a larger pad, and would have cost more to install and maintain.

With S&C Switchgear the cost was less than half; and now there are no batteries to maintain, no oil to change.

Information about S&C Switchgear is contained in this booklet . . . we would like to send you a copy.



S&C

ROBERT L. PFEIL

is Secretary and Assistant Construction Superintendent of Koontz-Wagner. He says, "Our work is almost altogether connected with industrial plants and public buildings. Because of our long and valuable experience in this field, we prefer to do our own engineering, and give our customers full advantage of our experience and know-how. We thus can be sure that the installation is entirely adequate, and frequently we are able to make substantial savings, as we did at Whirlpool."

S&C Electric Company
4439 Ravenswood Ave., Chicago 40, Illinois

Please send me your new booklet on S&C Metalclad Switchgear. No obligation on my part, of course.

Name_____ Title_____

Company_____

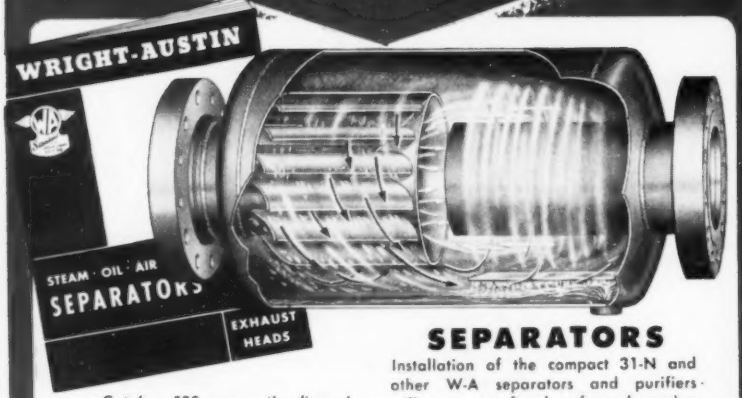
Address_____

City_____ Zone____ State_____

LOW COST PROTECTION for EXPENSIVE EQUIPMENT

WA Standard with STEAM USERS SINCE '94

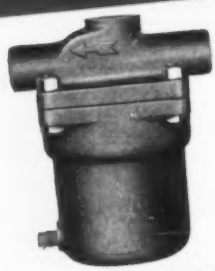
A nominal investment in well engineered accessories will protect your major capital investment in power equipment. Wright-Austin has served industry conscientiously for 60 years—offers you the confidence and peace of mind that comes from knowing you are using proven designs.



SEPARATORS

Installation of the compact 31-N and other W-A separators and purifiers will guarantee freedom from damaging entrainment, oil, rust, scale and condensate in your power lines.

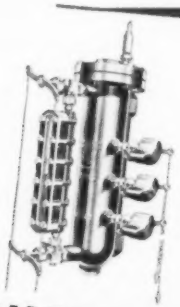
Catalog 500 covers the line of separators, purifiers, exhaust heads for steam, air and gas.



STEAM TRAPS

Operation of W-A traps is simple, fool-proof. Installation has been made easy and service can be performed with minimum effort and time.

Catalog 600 describes the wide range of W-A traps for steam, air and gas.



BOILER TRIM

Provisions for greater safety to equipment and worker plus peak efficiency is available at low cost in this line of 16 accessories.

Catalog 700 describes the complete line of alarms, gauges, controls, etc.

WA WRIGHT-AUSTIN COMPANY WA

3245 WIGHT STREET • DETROIT 7 MICH.

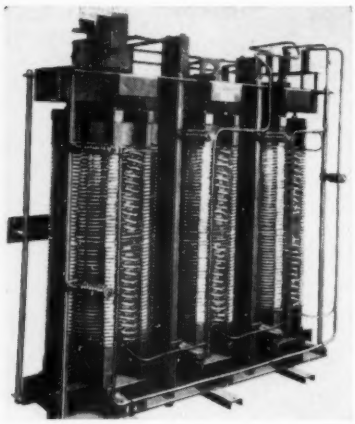
More EQUIPMENT NEWS

Begins on page 176

to applications where underside of the joint is difficult or impossible to reach for cleaning.

Compound is similar to paint in appearance, and is applied to the back of the joint with a brush.

General Electric Co, Schenectady 5, New York

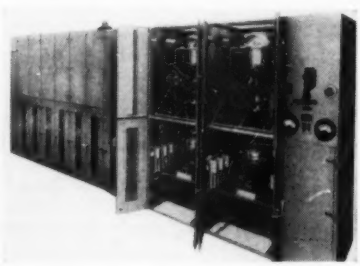


High Voltage Transformer

1034 • Dry type transformer for high voltage unit substations is designed to meet NEMA, ASA and JIC standards. Core operates at moderate flux density to insure quiet performance. Units are vacuum pressure impregnated with polymerizing varnish to give added protection during peak load period. They are available in sizes up to 2000 kva and 15,000 v. Bulletin HD-499.

Hevi Duty Electric Co, Milwaukee 1, Wisconsin

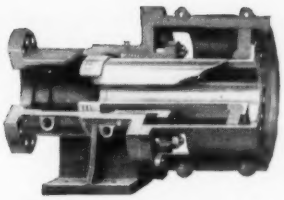
For more data on these items, use post cards p 185. Identify your request with item number.



Mercury Arc Rectifiers

1024 • Air-cooled, pumpless mercury arc rectifiers designed for high efficiency and power factor are available up to 5000-kw of dc power with a voltage range of 100 to 800. Automatic or manual control is optional. All units are designed to operate on any ac input supply from 220 to 13,800 v, three-phase, and 50/60 cycles as required.

Richardson-Allen Corp, 116-15 15th Ave, College Point, New York



ONLY ADSCO SLIP JOINTS CAN BE UNPACKED AND REPACKED AT FULL OPERATING PRESSURE

● ADSCO is the only manufacturer offering a slip-type expansion joint whose packing can be removed and replaced at full line pressure. In some makes of joints, new packing can be added, but when this packing becomes old, hard, and useless, it can not be removed without first shutting off the pressure . . . Not so with ADSCO's Piston-Ring Expansion Joints, which can be *unpacked* and repacked without the slightest interruption of service. Job is done under normal working conditions . . . but only if ADSCO Piston-Ring Joints are used.

● ADSCO Piston-Ring Joints are available in a full range of sizes, with 4″, 8″, or 12″ traverse per slip, for pressures to 400 psi and greater and for temperatures to 800F and higher. Slip is completely guided . . . split external guide permits smaller manholes . . . limit stops prevent over-travel of slip . . . polished surface can not be scored because slip is in contact with packing only . . . misalignment is prevented by both internal and external guiding.

● Call an ADSCO representative or write for Bulletin 35-15H.

AMERICAN DISTRICT STEAM COMPANY, INC.
NORTH TONAWANDA, NEW YORK
Since 1877

EXPANSION JOINTS • HEAT EXCHANGERS • STEAM TRAPS
STRAINERS • SEPARATORS
METERS

The vise that's a handy portable workbench

RIDGID

New No. 40 Tristand Pipe Vise

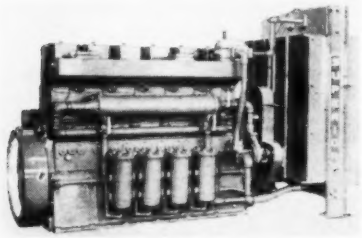
Easily taken to the job—legs fold in and chain for carrying, tray quickly on and off. Roomy top has pipe rest and efficient benders; tray keeps tools handy—and also makes Tristand extra rigid, won't fold up in use! Tool-steel Longrip jaws—firm grip but easy on polished pipe and tubing. Yoke No. 40, (old TSY-2½) 2½"; chain No. 45 (old TSC-4) 4". Buy these handy worksavers at your Supply House.

THE RIDGE TOOL COMPANY • ELYRIA, OHIO • U. S. A.

RIDGID
Work-Saver Pipe Tools

More EQUIPMENT NEWS

Begins on page 176

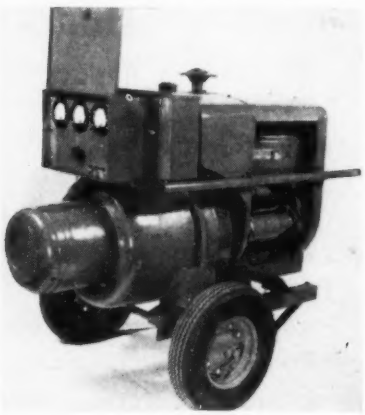


Gas Engine

1061 • *Superior* model G-825 is available in either 6- or 8-cylinder units. The 6-cylinder engine has continuous rating of 450 bhp at 900 rpm; 8-cylinder unit rating is 600 bhp at 900 rpm. Developed for drilling service, the engine is equally suitable for generator drives and industrial use.

Many parts of this engine are interchangeable with the company's model PTD diesel. The G-825 is equipped with air starting, oil-cooled pistons and pressure lubrication to main and connecting-rod bearings.

National Supply Co, P O Box 415, Pittsburgh, Pennsylvania



Portable Generator

1062 • New 5-kw ac unit generates current at 110/220 v, single phase, or 220/440, 3-phase. It is available with or without automatic voltage regulator, and powered with a 2 cylinder, 4-cycle type air-cooled engine. Bulletin SEP-10-50.

Katolight Corp, 624 N Front St, Mankato, Minnesota

For more data on these items, use post cards p 185. Identify your request with item number.

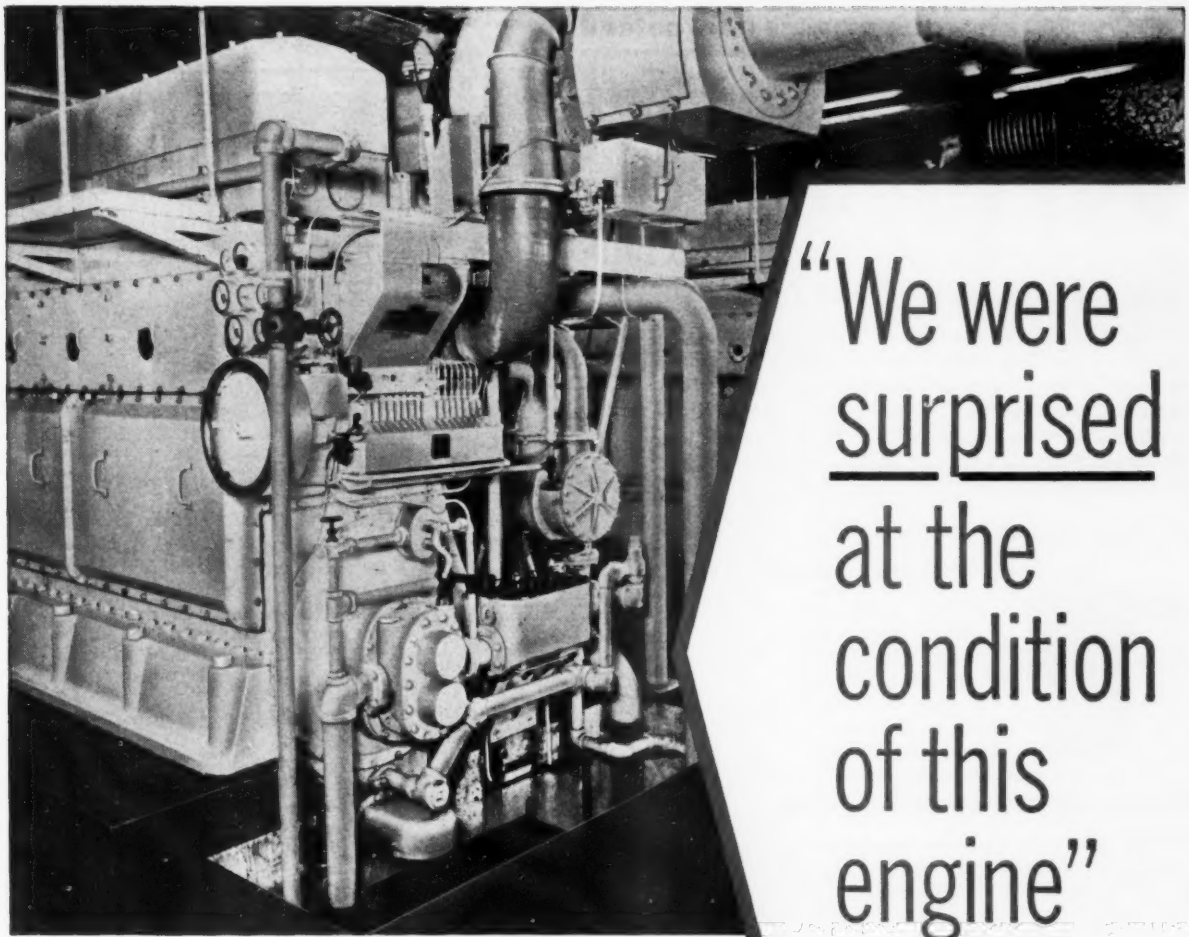
Light-Weight Diesel

1063 • Model 251A is a 6-cylinder, 4-cycle turbocharged diesel, 9 x 10½ in., rated 690 hp at 900 rpm. Net weight is 21,350 lb, dry. Base and frame are structural steel. It is intended for continuous duty or stand-by service.

The engine incorporates proved features of both the Alco 244 series V-type 9 x 10½ in. engine and the Alco 539 series 12½ x 13 in. engine.

American Locomotive Co, Schenectady 5, New York

(*Continued on page* 218)



"We were surprised at the condition of this engine"

... says G. V. Yarger,
Supt. Municipal Utilities
Waverly, Iowa

"When we finally opened up our Worthington, it was in the *best* condition I've ever seen a diesel engine that had operated such long hours and under such heavy loads as this unit. It had a total of 48,926 hours on it – 8,987 hours of tough operation since the last overhaul.

Mr. Yarger continues, "We've been using Sinclair RUBILENE® Heavy in the crankcase and RUBILENE H.D. 30 in the cylinder lubricator. These RUBILENES have kept the crankcase and upper portions of the cylinders exceptionally clean and bright, with no sign of carbon or deposits."

That's a typical report on the exceptional qualities of the Sinclair RUBILENES ... evidence that they could improve the efficiency of *your* diesels, too. Why not switch now? Contact your nearest Sinclair Representative or write Sinclair Refining Company, 600 Fifth Avenue, New York 20, N. Y.

SINCLAIR DIESEL OILS

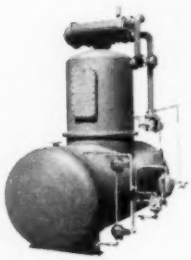
save wear and replacements

Stickle equipment is guaranteed to

Cut Steam Costs

OPEN COIL FEED WATER HEATERS

Guaranteed to heat water to a higher temperature in less space than any other heater; to deliver feed water to pump at same temperature as saturated steam in the heater. Deaerating and non-deaerating types. Deaerating type reduces oxygen content to .005 cc per liter of water. Steel or cast iron shells. Capacities: 3,000 to 300,000 pounds per hour. Bulletin 117.

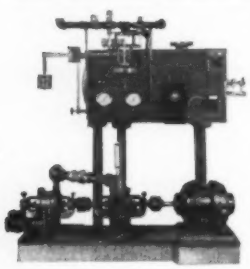


OPEN FLOAT STEAM TRAPS

Provide quick sure drainage of heating and processing units. Instantaneous discharge of air and non-condensable gases. Operate on time-tested open float principle. Self-regrinding valve and seat. No levers, hinges or pins to replace; no thermal elements or diaphragms to rupture or crack. Many still in use after 40 years. Sizes and styles for every need. Bulletins 115, 315, and 415.

REGULATING AND REDUCING VALVES

Provide automatic pressure regulation and reduction for liquid, air, steam. Used where most exacting control is essential. Self-contained. Single seated, balanced . . . or double seated, semi-balanced. Spring or lever weight-loaded. Lever or float operated. All parts accessible without removing valve body from the line. Available in wide range of sizes and styles. Bulletins 235 and 435.



DIFFERENTIAL DRAINAGE AND BOILER RETURN SYSTEM

A closed pumping system for returning condensate from heating and processing units to boilers at a temperature only 15 to 20 degrees lower than temperature of steam at operating pressure. Saves 10% to 25% of boiler fuel. Increases boiler capacity. Maintains higher, more uniform pressure. Delivers drier steam at higher temperature. Reduces raw make-up water and scale 85%. Bulletin 250.

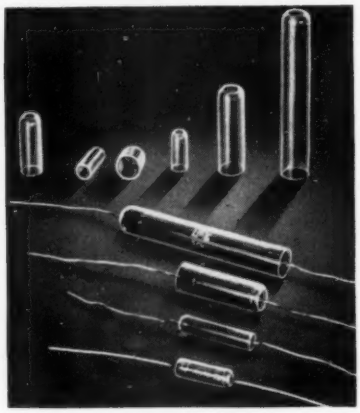
STICKLE STEAM SPECIALTIES COMPANY

2265 VALLEY AVENUE • INDIANAPOLIS 18, INDIANA

Stickle has engineered and built *guaranteed* steam specialties since 1905

More EQUIPMENT NEWS

Begins on page 176



Plastic Filters

1013 • Plastic filter can handle violent corrosives during continuous filtration. Fine structure of non-wetting, zero water absorption elements permits use in gas sparging where severe thermal cycling occurs. Filters have tensile strength up to 900 psi and elasticity modulus of 18,000 psi. They will remove particles larger than 5 microns and will provide flow rates up to 100 gpm per sq ft of area at a 10-lb pressure differential manufacturer claims.

M W Kellogg Co, PO Box 469, Jersey City 3, N. J.

For more data on these items, use post cards p 185. Identify your request with item number.

Laminated Fiber Filter Recharge

1064 • Laminated fiber disk recharge is said to have four to ten times the useful life of cellulose, waste or redwood for full-flow filtering of large quantities of oil. The laminated disks remove foreign solids smaller than two microns and absorption of these solids after 48 hours of draining at 70 F is 2½ times the weight of the recharge, manufacturer claims.

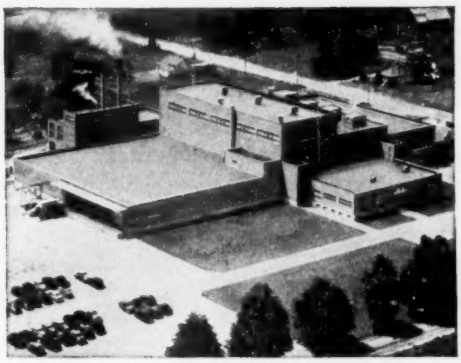
William W Nugent & Co, Inc, 410-12 N Hermitage Ave, Chicago, Ill.

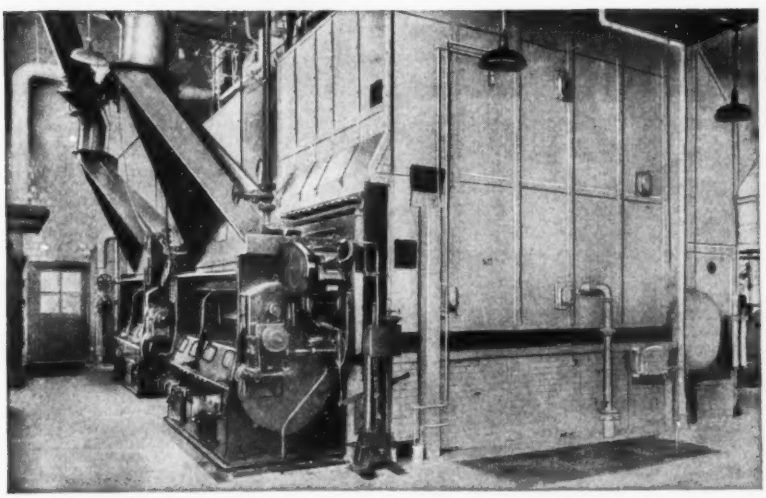
(*Continued on page 220*)

"COAL'S BEST FOR OUR MODERN PLANT!

It's low in cost . . . It's clean and convenient!"

says G. W. Peters, Engineering Manager
M&R DIETETIC LABORATORIES, INC.
makers of PREAM & SIMILAC





"We made a careful study of fuels and burning equipment before building our modern new plant in Sturgis, Michigan. This plant was designed to produce baby food. So the steam plant has to be clean and dust-free as well as economical to operate. Also, we wanted a fuel we could store safely and easily in order to insure ourselves against any shortages.

"We decided on bituminous coal—and the up-to-date installation shown here. It certainly fills the bill on every count. Our modern combustion equipment makes coal far more economical than any other fuel. Up-to-date coal and ash handling give us convenient operation completely free of dust nuisance."

Additional case histories, showing how other types of plants have saved money by burning coal the modern way, are available upon request.

Discover for yourself the great advantages of coal burned the modern way. Call in a consulting engineer. He'll show you how today's combustion equipment can give you 10% to 40% more power from a ton of bituminous coal than from equipment used only a few years ago. He'll show you how modern labor-saving coal and ash-handling equipment make a coal-fired installation clean, convenient, and dust-free.

If you plan to remodel or build a new plant, be sure to look into the low cost and convenience of bituminous coal. Consider coal's other advantages, too. It has reserves that are virtually inexhaustible. America's bituminous coal mining industry is the most efficient and productive in the world. With bituminous coal, you can be sure of plenty of fuel at relatively stable prices now and for years to come.

If you operate a steam plant, you can't afford to ignore these facts!

BITUMINOUS COAL in most places is today's lowest-cost fuel, and coal reserves in America are adequate for *hundreds of years to come.*

COAL production in the U.S.A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

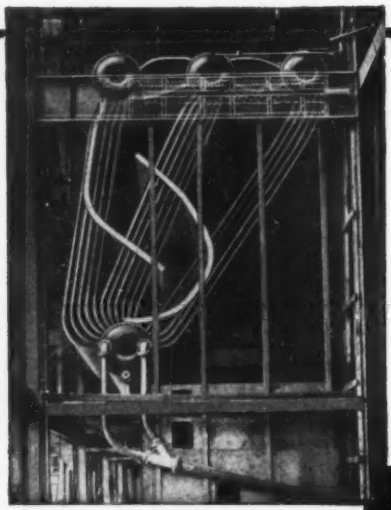
BITUMINOUS COAL INSTITUTE
A Department of National Coal Association,
Southern Bldg., Washington 5, D. C.

FOR HIGH EFFICIENCY FOR LOW COST

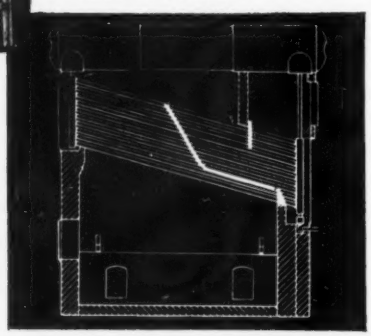
YOU CAN COUNT ON COAL!

MORE STEAM

QUICKLY EASILY



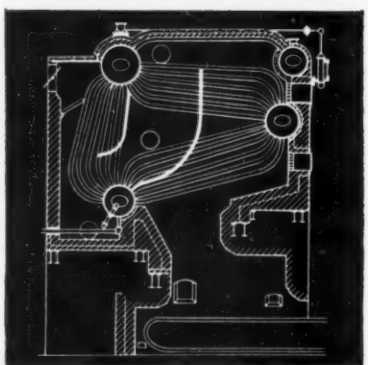
Steam output can be boosted quickly and easily by installing Enco baffles. These streamlined baffles prevent eddy currents and dead gas pockets. The cross-flow puts every square foot of heating surface to work.



Enco baffles reduce draft loss by doing away with bottlenecks in the passes. They save steam because soot blowers are more effective and used less often.

Each application is individually designed on the basis of 25 years experience with Enco baffling in all types of water-tube boilers.

Installations are made by skilled mechanics with selected materials.



FREE BOILER BAFFLES

EC504

● *A bulletin on boiler baffles gives valuable information which every engineer should have. Ask for bulletin BW 40. It's free.*

THE ENGINEER COMPANY

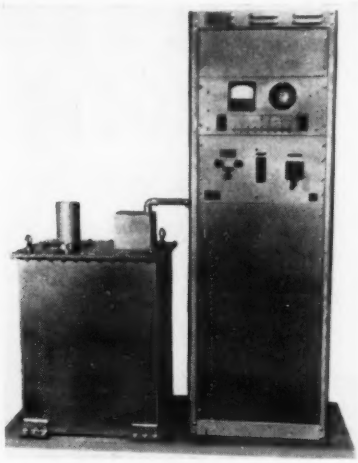
75 WEST STREET • NEW YORK, N.Y.

Enco Streamline Baffles

PRODUCED EXCLUSIVELY BY THE ENGINEER COMPANY

More EQUIPMENT NEWS

Begins on page 176



Insulation Testing

1021 • Non-destructive electrical insulation testing equipment features safety, simplicity and reliability. Sets consist of control unit, detector unit, high voltage corona-free testing transformer that incorporates means for picking up corona signals from equipment. Available in two models ranging from .75 kva to 10 kva continuously, 1.5 kva to 20 kva intermittently.

James G Biddle Co, 1316 Arch St, Philadelphia 7, Pa.

For more data on these items, use post cards p 185. Identify your request with item number.

Valve Actuators

1065 • New line of valve actuators is designed for automatic operation of gate, plug, diaphragm, butterfly, and flow control valves. Actuator is mounted directly on the valve without need of outside support. The units are power operated by gas, air, oil, water or steam, may have direct or remote control. Bulletin 3000.

Ledeen Mfg Co, 1600 S San Pedro St, Los Angeles 15, California

Industrial Alarm

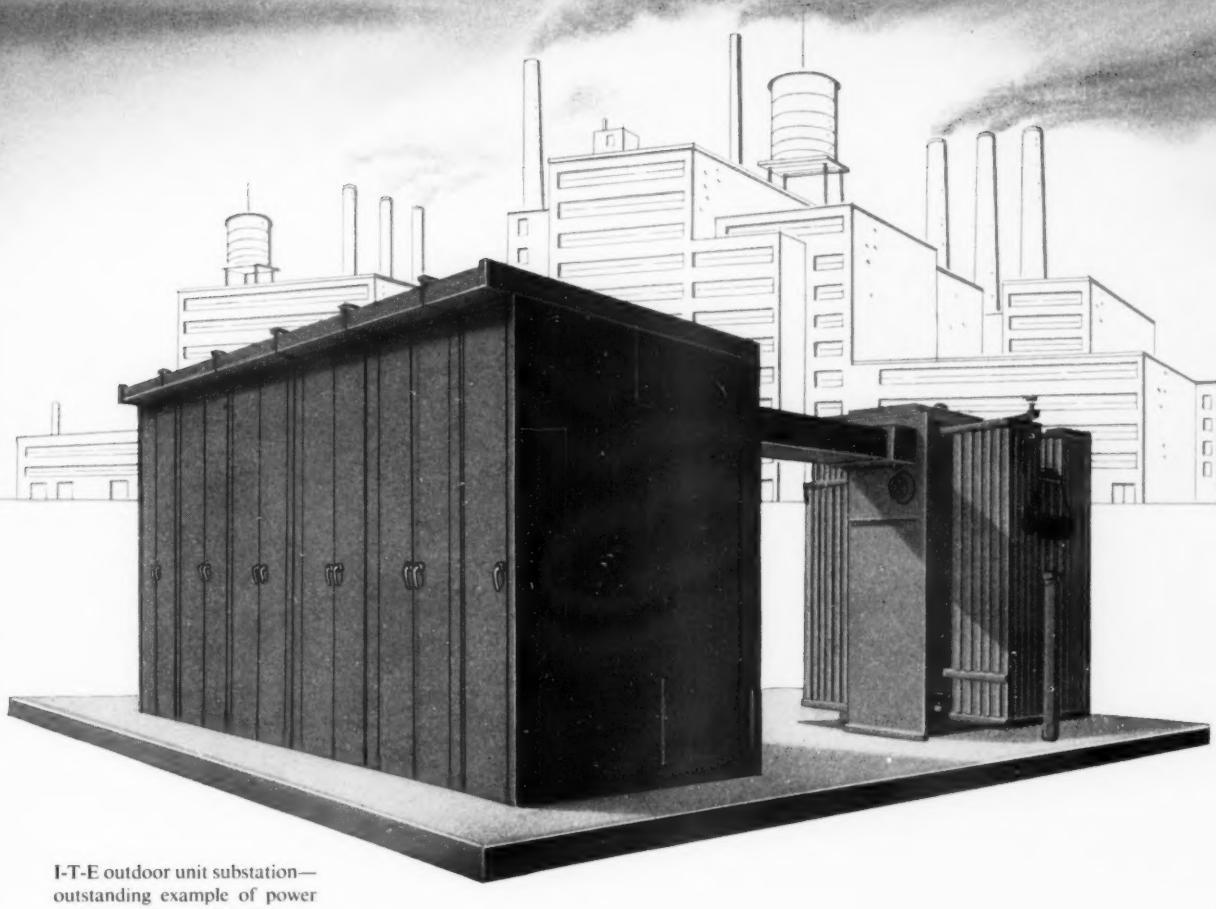
1066 • Automatically and continuously self-supervised alarm circuit automatically signals the operator if the alarm system becomes inoperative due to failure of any component in the system itself. Unit has compact "plug-in" design, and may be used for either normally open or normally closed field connections. Manufacturer recommends it for process supervision and protection service. Catalog M-1.

Scam Corp, 3909 West Irving Park, Chicago 18, Illinois

(*Continued on page* 226)

Planned Power Distribution

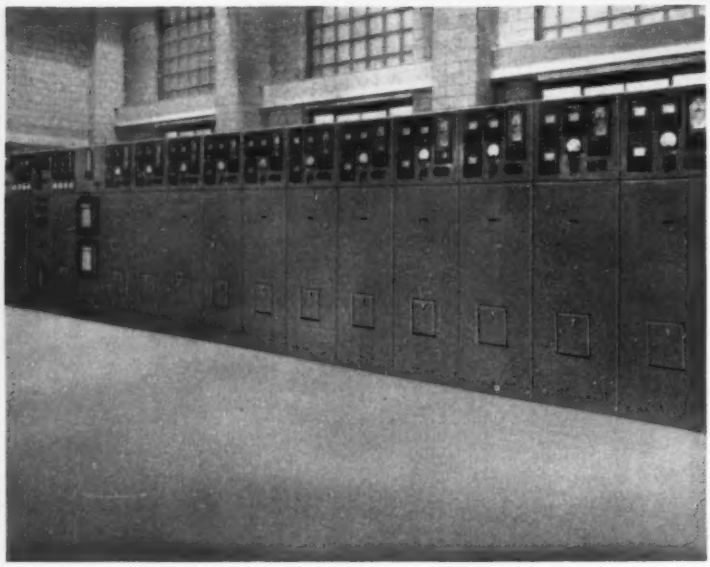
—first step toward increased plant efficiency



I-T-E outdoor unit substation—outstanding example of power equipment planned for efficiency. This substation, a durable, weatherproof unit of transformer and switchgear, can be located close to load center—yet out-of-doors, where it will not take up premium production space inside the plant.

Power is fundamental. The most modern plant, the latest-type production lines can be only as efficient as the electrical distribution system that feeds them.

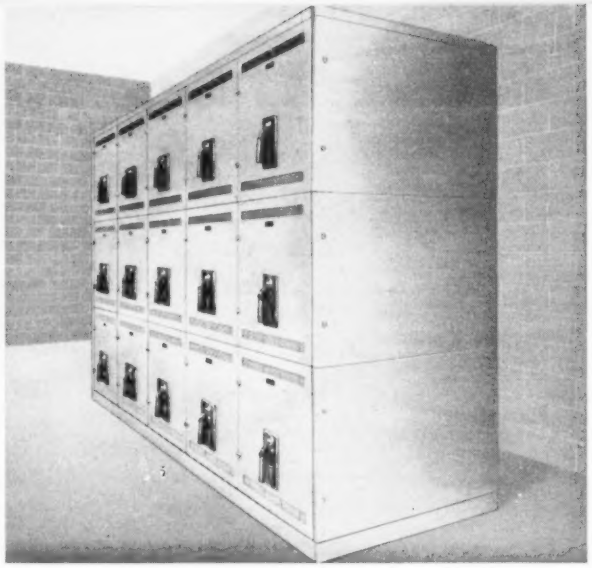
Plan ahead now, and avoid "patchwork" later. An I-T-E application engineer will gladly advise you how to get more efficiency from your power devices, how to lower distribution costs, and get positive electrical protection for your plant.



I-T-E METAL-CLAD SWITCHGEAR

4160 volts — 600, 1200, 2000 amperes
50,000, 150,000, 250,000 KVA interrupting

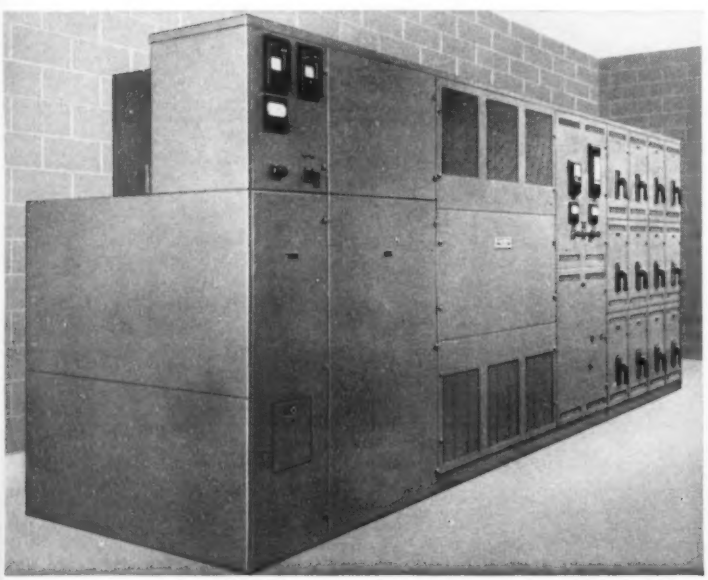
For protection of main incoming lines and feeders. Modern horizontal drawout construction guarantees savings in inspection and maintenance.



600-VOLT DISTRIBUTION SWITCHGEAR

600 volts — 6,000 amperes and below
15,000 to 100,000 amperes interrupting

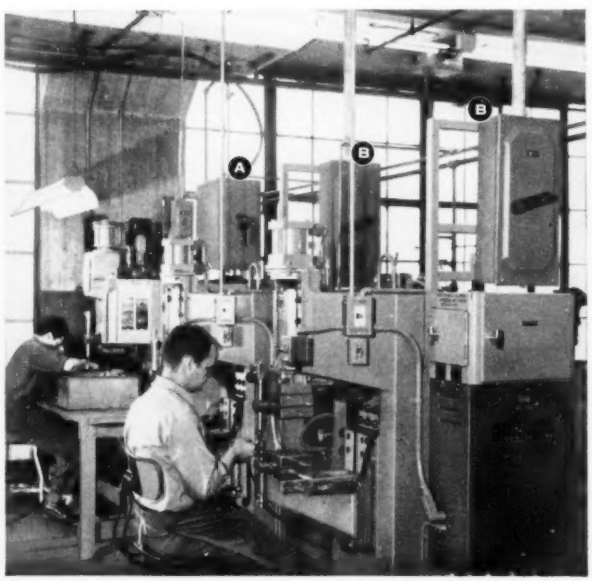
For protection of low-voltage incoming lines and feeders.



UNIT SUBSTATIONS

300 KVA and above—Primary voltage 480 and above

Coordinated Metal-clad and 600-volt switchgear, plus transformer. Substations reduce distribution losses by stepping down voltage near point of utilization.



INDIVIDUALLY-ENCLOSED CIRCUIT BREAKERS

120-600 volts 10-6,000 amperes
5,000-100,000 amperes interrupting

A complete line of large air (**A**), and molded case (**B**) circuit breakers for protection of single circuits to almost any type of plant equipment.

From power line to production line

. . . I-T-E BOOSTS PLANT EFFICIENCY

From the main plant switchboard to the smallest circuit breaker, I-T-E equipment boosts plant efficiency. Equipment is designed to facilitate efficient power distribution, to guard against overloads and short circuits, and to allow for quick restoration of service in the event of sudden power interruption.

Your plant structure and costly capital equipment are fully protected against electrical hazards at all times. Loads are fed and maintained at proper, efficient voltage. Production lines are kept on the go.

In line with latest thinking, equipment is compact, self-contained—can be located either *indoors* or *outdoors*, according to requirements. Rugged, durable enclosures are available to satisfy every plant need.

Modern design complements modern engineering. Standardized units facilitate expansion. Circuit breakers are easy to get at; maintenance is simple. Breakers can be quickly adjusted to compensate for load changes.

And throughout—safety is the keynote

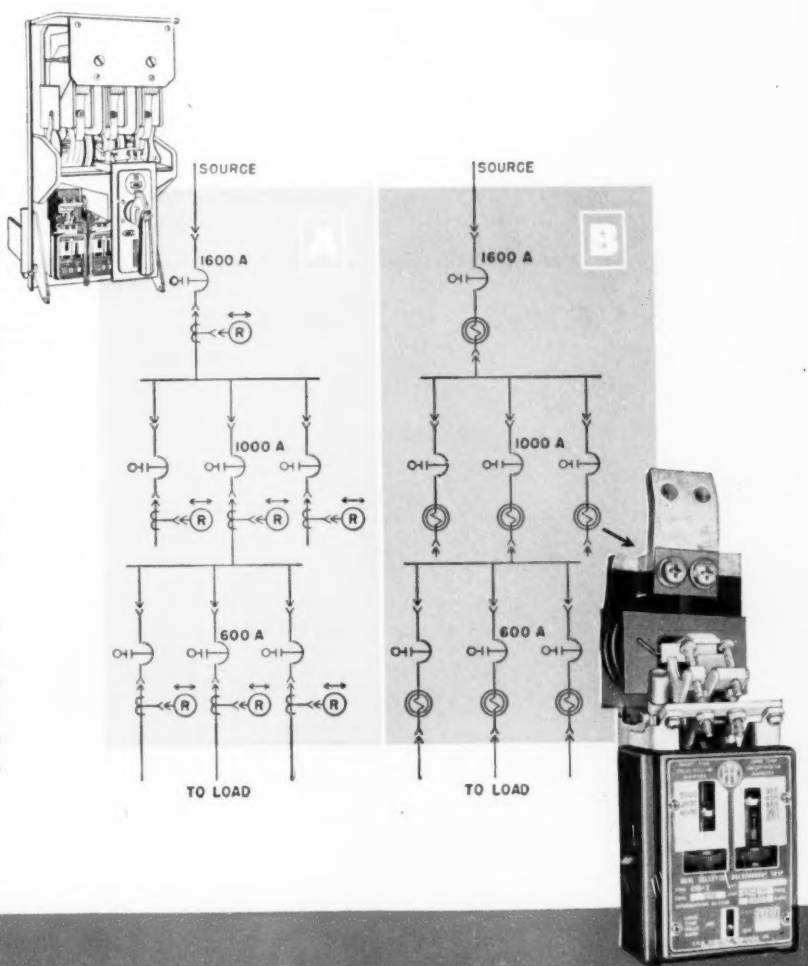
For the *utmost* in service continuity . . . I-T-E *Selective Tripping*

For those 600-volt switchgear applications in which absolute continuity of service is essential, I-T-E offers an advanced selective-trip device which mounts as an *integral* part of the circuit breaker.

By allowing the circuit breaker closest to a fault to open *first*, while other breakers remain closed, the selective-trip device *localizes* trouble. Thus, batch processes and other critical loads are insured against costly and unnecessary shutdown.

Through use of simple, compact I-T-E selective-trip devices, plants can realize an initial cost saving as high as *60%*!

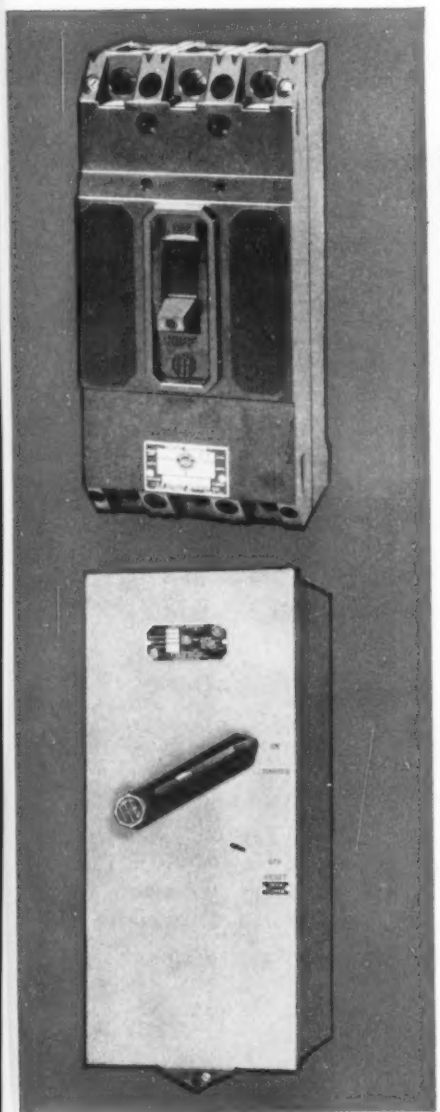
Although Systems A and B (right) provide the same high degree of selective-trip protection, System B actually costs far less to install. I-T-E Direct-Acting Dual-Selective Overcurrent Trip Devices eliminate separate relays, save space, and reduce maintenance.



I-T-E CIRCUIT BREAKER COMPANY

Dependable I-T-E Circuit Breakers

THE RIGHT FRAME SIZE, RATING, AND ENCLOSURE TO FIT EACH JOB



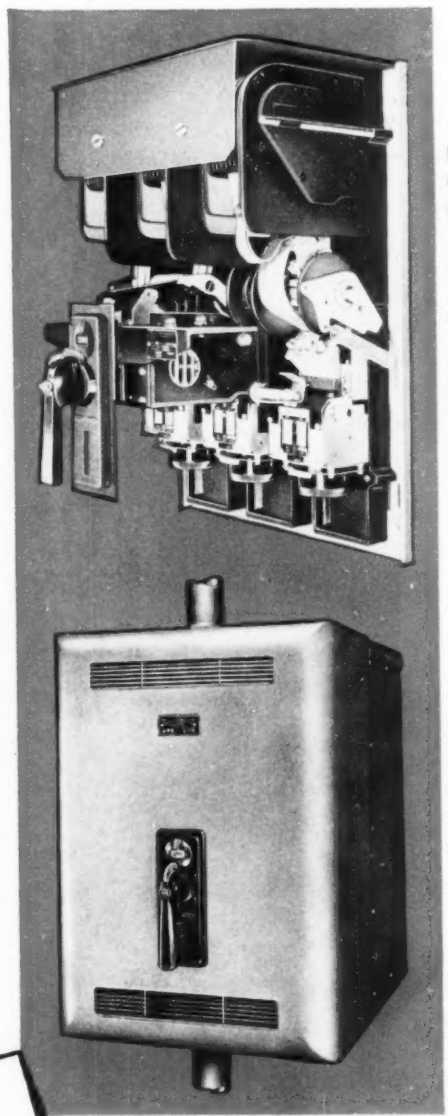
SMALL AIR CIRCUIT BREAKERS (MOLDED CASE)

4 Frame Sizes:

10 to 600 amperes
600 volts a-c maximum
250 volts d-c maximum

ENCLOSURE TYPES INCLUDE:

- general purpose
- semi-dust-tight
- water- and dust-tight
- explosion-proof



LARGE AIR CIRCUIT BREAKERS (URELITES)

4 Sizes:

15 to 6,000 amperes continuous
15,000 to 100,000 amperes interrupting up to 600 volts a-c, 250 volts d-c

ENCLOSURE TYPES INCLUDE:

- general purpose
- panel-mounted
- dust-tight
- weatherproof

FROM COAST TO COAST— STRATEGICALLY LOCATED I-T-E SALES OFFICES STAND READY TO SERVE YOU:

Birmingham, Ala.
Boston, Mass.
Buffalo, N.Y.
Butte, Mont.
Charleston, W. Va.
Charlotte, N.C.
Chicago, Ill.
Cincinnati, O.
Cleveland, O.
Dallas, Tex.
Denver, Col.
Detroit, Mich.
El Paso, Tex.
Houston, Tex.
Indianapolis, Ind.
Jackson, Miss.
Jacksonville, Fla.
Little Rock, Ark.
Los Angeles, Calif.
Memphis, Tenn.
Miami, Fla.
Minneapolis, Minn.
New Orleans, La.
N. Kansas City, Mo.
New York, N.Y.
Omaha, Neb.
Philadelphia, Pa.
Pittsburgh, Pa.
Portland, Ore.
San Francisco, Calif.
Santa Fe, N. Mex.
St. Louis, Mo.
Salt Lake City, Utah
Seattle, Wash.
Tucson, Ariz.
Washington, D. C.
Wilkes-Barre, Pa.

I-T-E CIRCUIT BREAKER CO.

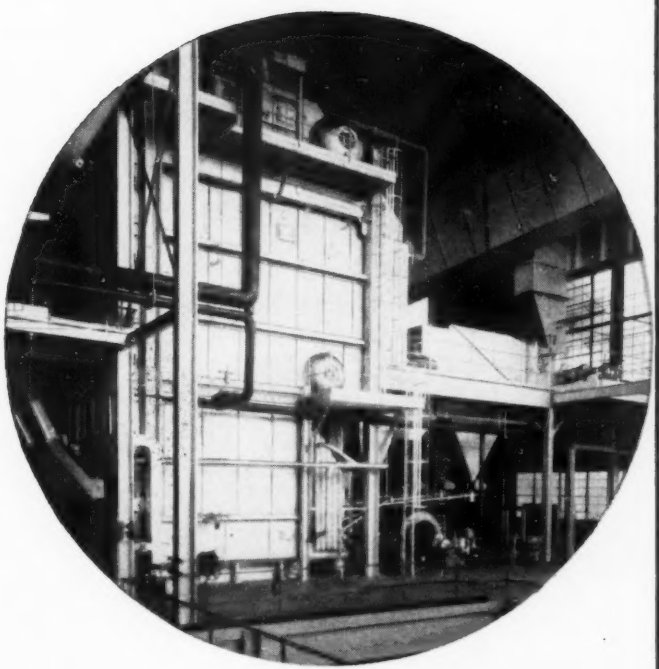
19th and HAMILTON STS., PHILADELPHIA 30, PA.

Power Switching Equipment: R&IE Equipment Div., Greensburg, Pa.
Canadian Mfg. & Sales: Eastern Power Devices, Ltd., Toronto
Export Sales: Philips Export Corp., N. Y.

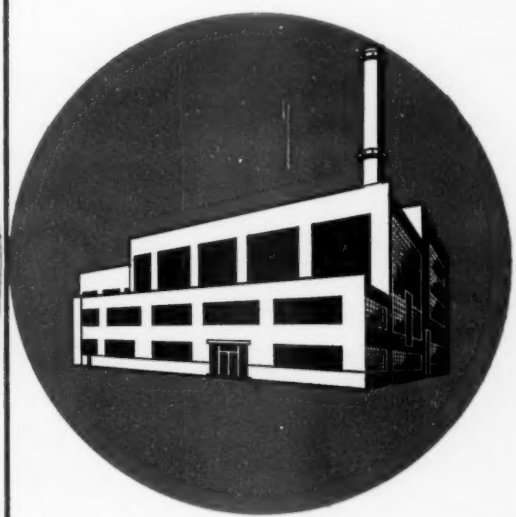
circuit breakers • switchgear • unit substations • isolated phase bus structures • mechanical rectifiers • electronic components • special products.

City of Manitowoc installs fifth WICKES steam generator

To provide a dependable source of power for the City of Manitowoc, Wisconsin, the Manitowoc Public Utilities Commission has just installed a fifth WICKES Steam Generator capable of producing 175,000 lbs. of steam per hour at 525 psi. Final steam temperature is 750°F. The new WICKES Boiler has 11,600 sq. ft. of heating surface. It is equipped with an economizer and fired by spreader stoker.



R. E. Cannard — Chief Engineer and General Manager



WICKES can fill your requirements for all types of multiple drum boilers generating up to 250,000 lbs. steam per hour at pressures up to 1000 psi. adaptable to any standard method of firing — oil, gas, single retort underfeed or spreader stoker. For pressures up to 900 psi. with sustained steam production up to 35,000 lbs. WICKES Type A Boilers can be shop assembled, ready for immediate installation. Write today for descriptive literature or consult your nearest WICKES representative.

wickes

THE WICKES BOILER CO., SAGINAW, MICHIGAN RECOGNIZED QUALITY SINCE 1854
DIVISION OF THE WICKES CORPORATION

SALES OFFICES: Albuquerque, N. M. • Atlanta • Boston • Charlotte, N. C. • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Greensboro, N. C. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Orangeburgh, S. C. • Pittsburgh • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tampa, Fla. • Tulsa • Washington, D. C.

150

Little stories of big savings in LAGONDA tube cleaning

The case of the Insistent Engineer

Happened at an important middle western utility. One of the engineers kept insisting that the water treatment they were using should be supplemented by occasional mechanical tube cleaning, which had not been used for four years. Nobody believed him, but his persistence finally won out to the effect that they consented to clean one boiler with Lagonda tube cleaners, just to see. Result, startling increased efficiency of the unit, an unexpectedly large amount of scale removed, and the scheduling of Lagonda cleaning for all the boilers not only in that plant, but in all other plants of the system. Further result, orchids for the insistent engineer.

Y-2-1

GET BULLETIN Y-29
with details on all types of cutter heads and motors for cleaning all tubes, small, large, curved, straight. On request.

LAGONDA
...the oldest name in tube cleaning!

ELLIOTT COMPANY
LAGONDA DIVISION · SPRINGFIELD, OHIO
Plants at: Jeannette, Pa. • Ridgway, Pa. • Ampere, N. J. • Springfield, O. • Newark, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

More EQUIPMENT NEWS

Begins on page 176

Megohm Voltmeter

1003 • Model 640 megohm voltmeter provides a 500-v dc source for insulation testing by means of a hand crank generator. Unit can measure up to 200 megohms. Resistance scales run from 0 to 2000 ohms. Voltage ranges are 0-150, 0-300, 0-600 ac and dc.

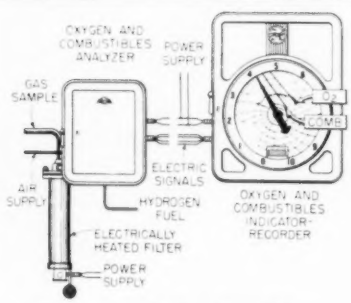
All Mail Sales Co, 100 Park Place, New York 7, N. Y.

Through-type Transformer

1023 • Through-type current transformer for outdoor service uses biased *Hipersil* cores to insure high accuracy with smallest practical size. Units are available in 200, 400 and 800-a primary ratings with rating factors of 2 and 1.5. Obround glass laminate tube provides opening for single-phase, 3-wire or three-phase, 4-wire metering of standard 600-v power cables.

Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pennsylvania

For more data on these items, use post cards p 185. Identify your request with item number.



Oxygen and Combustibles

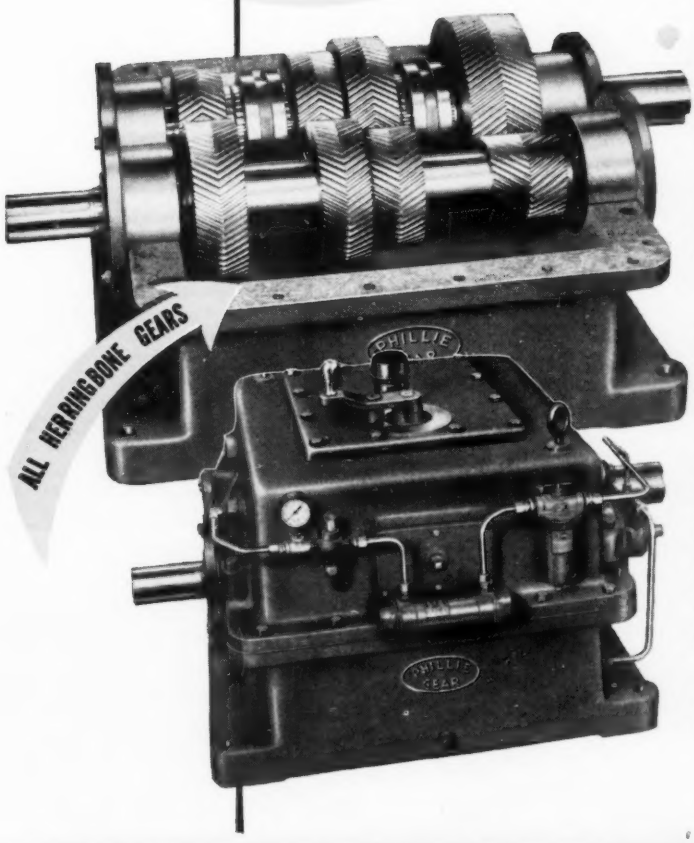
1036 • Combination oxygen and combustible analyzer, now offered in single compact unit, indicates or automatically controls adjustments needed for maximum combustion efficiency. System uses compressed air and hydrogen for catalytic combustion. It is accurate within ±0.25% by volume of oxygen and combustibles contents in sample manufacturer claims.

Bailey Meter Co. 1050 Ivanhoe Rd. Cleveland 10, Ohio

Now Available...

a Change-Speed Unit

- **2, 3 or 4 Speed Combinations**
- **Wide Range of Ratios**
- **For Speed Reduction, Speed Increasing, or a combination of both**



Industry has long needed a standardized Change Speed Unit, designed and built to *eliminate* the high cost and delayed delivery of *specially built* units.

Philadelphia Gear is now able to offer a line of these units, backed by 20 years of knowledge and experience in the building of Change Speed Units constructed to individual specifications . . . Hundreds of these Units are today in successful operation.

These new Philadelphia Standardized Units are positive, reliable Geared Drives, using Herringbone Gears throughout,—and they provide definite ratios of Speed Reduction, Speed Increasing, or a combination of both. There are no belts to wear out and cause speed variations. They are available for a wide range of horsepowers, and in 2, 3 or 4 Speed Units (photos show a 4 Speed Unit).

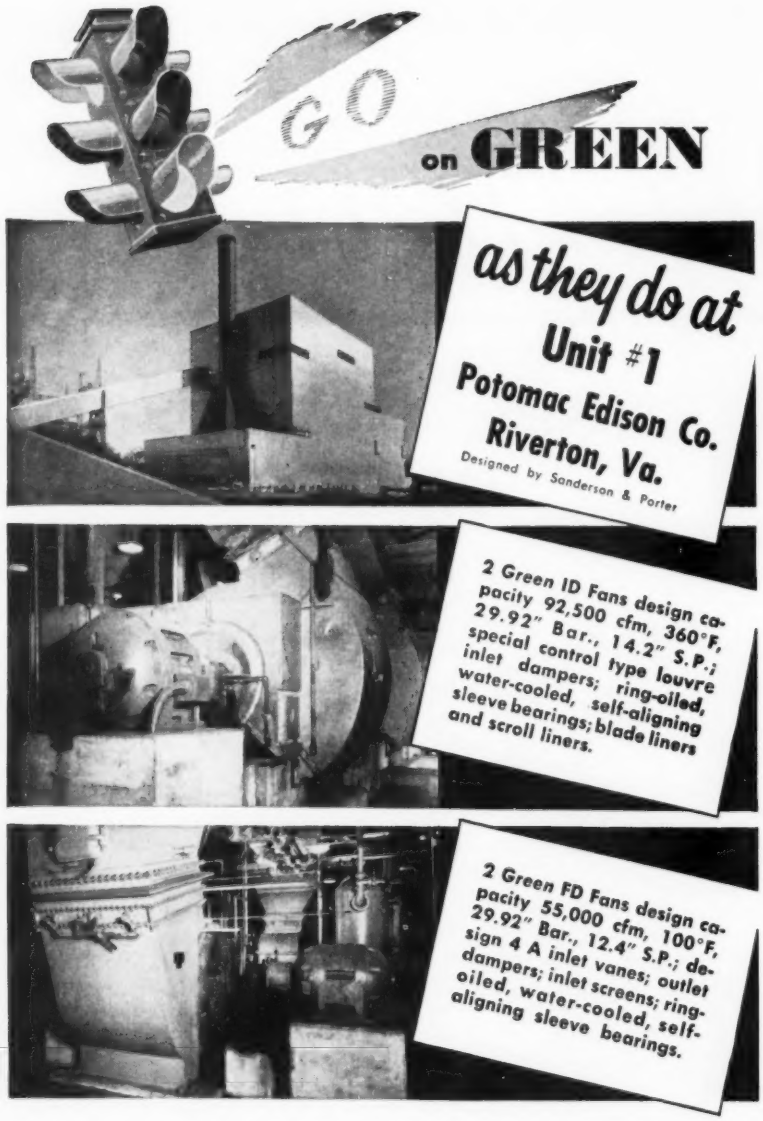
A new Catalog CSU-52 illustrates and describes these Units in detail. Send for a copy.

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK · PITTSBURGH · CHICAGO · HOUSTON · LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls


GO
on GREEN
as they do at
Unit #1
Potomac Edison Co.
Riverton, Va.
Designed by Sanderson & Porter
2 Green ID Fans design capacity 92,500 cfm, 360°F, 29.92" Bar., 14.2" S.P.; special control type louvre inlet dampers; ring-oiled, water-cooled, self-aligning sleeve bearings; blade liners and scroll liners.
2 Green FD Fans design capacity 55,000 cfm, 100°F, 29.92" Bar., 12.4" S.P.; design 4 A inlet vanes; outlet dampers; inlet screens; ring-oiled, water-cooled, self-aligning sleeve bearings.

The list grows—the list of utility and industrial steam generating plants for which Green Fans were selected to provide the air necessary for combustion purposes.

Draft fans yield to no other equipment in their importance to efficient steaming. They must be properly designed for the requirements in each plant respectively. They must be conservatively rated. And they must be durably constructed.

Green Fans fulfill these basic requirements. You wouldn't find them in so many large utility plants and large industrial plants unless they had thoroughly proved their worth.

Our Catalog No. 168 tells all about Green Fans. Write for a copy.

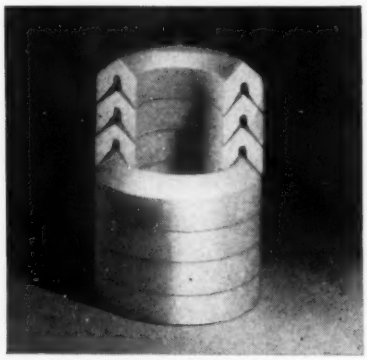
THE GREEN Fuel Economizer COMPANY INC.

- Economizers
- Fans
- Air Heaters
- Cinder traps
- Aerodyne Dust Collectors

BEACON 3, NEW YORK

More EQUIPMENT NEWS

Begins on page 176



V-Seal Packing

1007 • Series S-2500 vee-seal pressure responsive packing is made of *Kelon-T* (tetrafluoroethylene resin). Manufacturer recommends it for valve stems, hydraulic cylinders, jacks, lifts and pumps. Useful temperature range is from –110 to + 500 F.

Packing is said to be self-sealing and self-adjusting. Upon application of hydraulic pressure, seal expands against the stuffing box and inward against the stem for tight sealing.

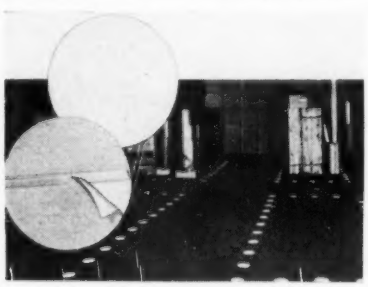
W S Shamban & Co, 11617 W Jefferson Blvd, Culver City, Calif.

Insulating Varnish

1068 • Heat-resistant insulating varnish, No. 180, is said to show no adverse effects on electrical applications when operated at temperatures as high as 180 C. It has a clear color, excellent oil and moisture resistance, with a dry dielectric strength of 2100 v per mil, according to the manufacturer.

Irvington Varnish & Insulator Co, Sales Promotion Dept, Irvington, N. J.

For more data on these items, use post cards p 185. Identify your request with item number.



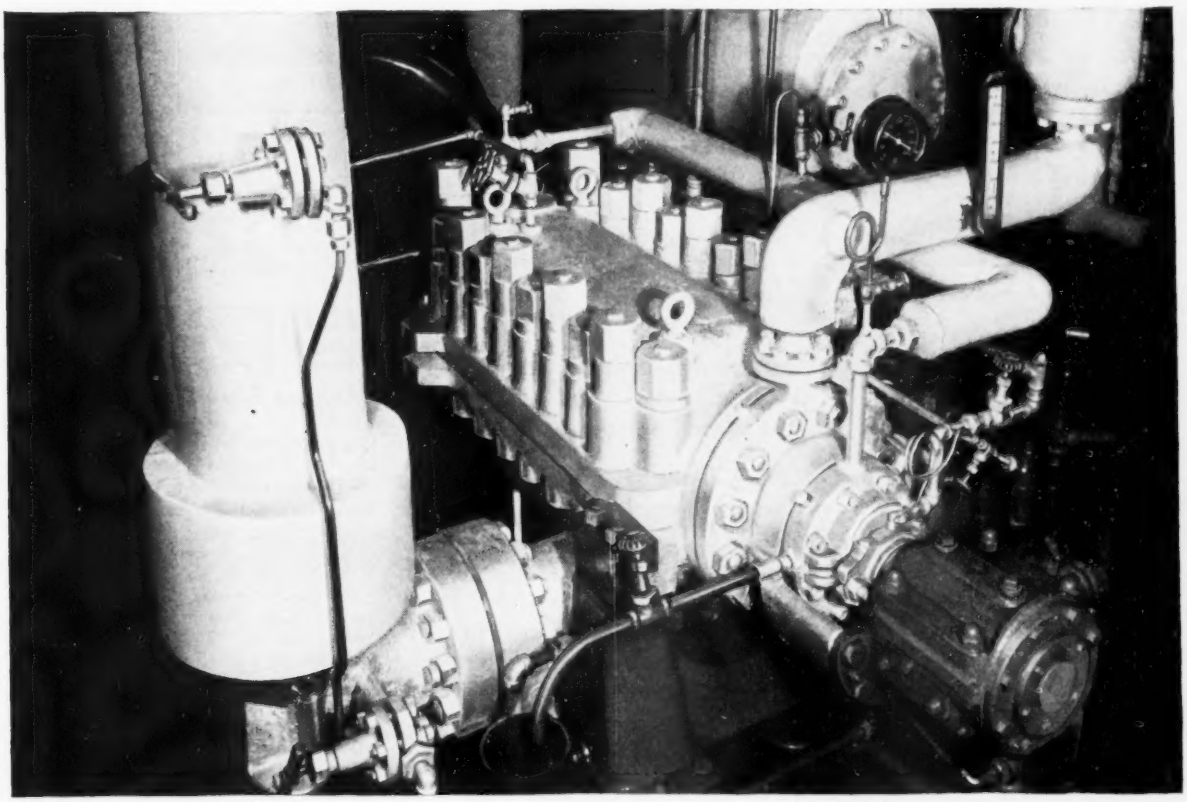
Self-Adhesive Markers

1030 • Self-adhesive aisle markers offer simplicity of installation, resistance to abrasion and common corrosives and high degree of visibility. Made of .005-in. thick plastic, they will not impede plant traffic. Stock circular markers are available in 2 to 5-in. dia, arrows in 2 to 5-in. sizes; special sizes and shapes made to order.

W. H. Brady Co, 727 W Glendale Ave, Milwaukee 12, Wisconsin

100,000 HOURS

and not opened yet!



This Ingersoll-Rand High Pressure Boiler Feed Pump installed 15 years ago has never been opened for inspection . . . and it still meets capacity and pressure requirements.

The Ingersoll-Rand Class HT pump shown above was installed in 1938 at the Windsor Station, owned jointly by The Ohio Power Company (part of the American Gas & Electric Company) and the West Penn Power Company (in the West Penn Electric Company system). Since that time, it has operated for over 100,000 hours—pumping 1025 gpm of 380° F boiler feed water at 415 psi intake and 1900 psi discharge. Throughout this entire 15 year period, the casing and high pressure breakdown have never been opened for inspection.

There are five other I-R Class HT pumps at this station. Four of these have chalked up unopened service records of from 50,000 to 80,000 hours each.

These outstanding operating records are the result of competent pump operation and feedwater control on the part of the station's personnel—and the careful material selection and high standards of construction inherent in every I-R boiler feed pump.

For *proved dependability* in high pressure service, it pays to specify Ingersoll-Rand pumps.

Ingersoll-Rand

948-10

Cameron Pump Division
11 Broadway, New York 4, N. Y.

ROCK DRILLS • COMPRESSORS • AIR & ELECTRIC TOOLS • VACUUM EQUIPMENT • PUMPS • GAS & DIESEL ENGINES

WHY INSULATE YOUR CONDENSER TUBES?

You may be doing just that if your plans don't include CHLORINATION EQUIPMENT for slime control by WALLACE & TIERNAN.

Chlorination equipment because it controls slime that *grows* on the walls of condenser tubes not protected against it. Enough of the growth eventually seriously reduces heat transfer efficiency — actually *insulates* your steam from the cooling water. Back pressures go up, production drops, operating and maintenance costs rise, and eventual shut-down becomes necessary for regular clean-out periods.

Wallace & Tiernan equipment because it is versatile, sturdy and dependable — proven by thousands of successful installations, vouched for by satisfied users everywhere-and because there's a Wallace & Tiernan chlorinator for every job. Write today for information on how Wallace & Tiernan chlorination may help you solve *your* slime problem.

NO WATER IS SLIME-FREE

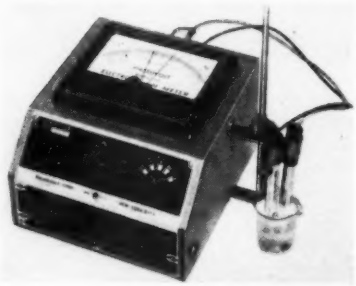
regardless of the source. Chlorination helps reduce slime in make-up or cooling water.

CD-37

WALLACE & TIERNAN
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES

More EQUIPMENT NEWS

Begins on page 176



pH Meter

1027 • Portable pH meter, Model 125, provides 2000-hr service with power from 3 ordinary radio batteries. Unit is also available for operation with 100-125-v ac. Scale length of 5½ in. permits readings of 0.02 pH reproducible and accurate to 0.03 pH.

Photovolt Corp, 95 Madison Ave, New York 16, N. Y.

For more data on these items, use post cards p 185. Identify your request with item number.

Oxygen Recording Equipment

1043 • New apparatus solves many measuring problems by using oxygen as direct source of measurement. Manufacturer claims this method increases efficiency of combustion, process, product and safety control. High speed response—initial, 8 to 12 sec; 90% of final reading, 35 sec—is provided by the equipment.

Calibrated accuracy of 0.15% oxygen against standard mixtures can be adjusted by recorder-dial rheostats to any plant standard. Null-balance measurement method provides stability of better than 0.15% oxygen. Recording equipment includes (1) a thermo-magnetic analyzer (2) a *Speedomax* recorder (3) a sample conditioner. Further details are available from manufacturer.

Leeds & Northrup Co, 4934 Stenton Ave, Philadelphia 44, Pa.

Air Sampler

1069 • High-volume air sampler samples large volumes of air for particulate matter by means of filter papers. Unit weighs 10 lb, consists of filter holder, pump and motor, fan housing assembly, variable orifice meter for measuring rate of flow. Three different types of filter paper deliver from 18 to 72 cfm

Staplex Co, 68-72 Jay St, Brooklyn 1, New York

Heavy-Duty Air Hose

1070 • New *Commander* air hose is suitable for working pressures up to 400 psi. Hose is reinforced with a single braid of high-tensile steel wire.

It is designed for use where high working pressures are required or where the cover is subjected to severe abrasion. Available in ½, ¾ and 1 in. sizes.

B F Goodrich Co, Akron, Ohio

Before You Buy Blow-off Valves *ASK THESE QUESTIONS...*

EDWARD BLOW-OFF VALVES

Design simplicity . . . operating ease, low maintenance cost . . . stay tight, no trick construction. ASA pressure classes 300, 600, 900-1500, 2500 lb. Sizes 1½", 2" 2½"—straightway or angle flanged or socket welding ends—Stellite or Evalloy trim.

Q. *In a tandem blow-off valve hook-up, will both valves stay tight?*

With Edward, the valve nearest the boiler is the same design as its mate. Both are "sealing" valves.

Q. *Is the packing out of the highest temperature zone?*

Edward blow-off valves have only one set of packing, for the stem is the only working part that needs to be packed. Packing is above a condensate cooling chamber, removed from highest line temperatures.

Q. *Do the valves have backseats, so that packing can be replaced in service?*

With Edward, the answer is "yes".

Q. *Can leakage start through bonnet misalignment?*

Not with Edward blow-off valves. The Edward one-piece bonnet has no yoke posts to permit distortion.

Q. *Are parts of both blow-off valves interchangeable?*

Edward answers "yes". And with fewer working parts Edward blow-off valves need less maintenance. If part replacement is necessary, repairs are easier and less expensive with Edward.

Q. *Can the seat and disk bind together?*

Not Edward, because the disk lifts off the seat on operating instead of grinding against it. There is no sleeve to gall against the seat.

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
1220 WEST 144th STREET
EAST CHICAGO, INDIANA

Another Product

Edward built the first steel blow-off valves. Installation records in America's major steam plants for nearly 50 years tell this story—no blow-off valves are better designed for year-in, year-out service with low maintenance. Write for Edward blow-off valve catalog, No. 12-D.

Everlasting
the valve that IMPROVES with use

In the unique EVERLASTING Valve, the disc never leaves the seat, even when the valve is full open. The disc moves across the sealing surface with a rotating motion, thus regrinding one to the other.

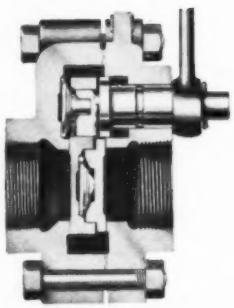
Therefore, this self-grinding movement of the disc across the sealing faces, each time the valve is operated, continuously polishes the sealing faces, with the result that the seal actually improves with use.

This feature, coupled with the fact that the EVERLASTING Valve is quick-acting, easy to operate, and drop-tight, makes it the ideal valve for many services.

For more than 40 years, the simple, sturdy construction and ingenious mechanical principles of the EVERLASTING Valve have built up an enviable reputation for dependable trouble-free operation, long service life, and low maintenance expense.

These valves are widely used throughout industry, and are in particular demand wherever quick and easy operation, leakproof closure, and thorough reliability are important when handling fluids such as steam, water, oil, acids, alkalies, process liquids, air, etc.

EVERLASTING Valves are made in a range of sizes for various pressures, and are available in a variety of operating arrangements for greatest convenience in the individual installation.



Sectional view through standard Everlasting Valve

WRITE FOR BULLETIN

EVERLASTING VALVE CO., 49 Fisk Street, Jersey City 5, N. J.

Everlasting Valves

TRADE MARK "EVERLASTING" REG. U.S. PAT. OFF.

EV373

FOR EVERLASTING PROTECTION

More EQUIPMENT NEWS

Begins on page 176

Hydraulically-Driven Stoker

1071 • *Fluid-Ram* single retort underfeed stoker is hydraulically driven and controlled. Unit provides unobstructed access to fire, sifting and ashpit doors. Hydraulic fuel feed control offers an infinite range of fuel regulation, making the unit suitable for automatic combustion control where wide load range operation is desired. Bulletin SB-47.

Erie City Iron Works, Erie, Pa.

Silicone-Coated Glass Cloth

1072 • New mechanical grade E-959, silicone-rubber-coated glass cloth has excellent tensile strength and surface hardness. Film hardness is said to be 3 to 4 times as great as previous rubber coatings. Tensile strength on specimens .015 in. thick is 350 lb per inch of width. Moisture absorption is low, and dry heat resistance is high. Manufacturer claims gaskets made of the material will not rot, soften or decompose.

Mica Insulator Co, Scenectady 1, N. Y.

For more data on these items, use post cards p 185. Identify your request with item number.

Conduit Straps

1073 • New line of malleable iron straps is said to have greater strength, less weight and improved support. The design provides a uniform series of one-hole straps for rigid conduit ½ to 6 in. diameter, and for EMT, ½ to 2 in. Weight savings range from 7 to 24%, width reductions to 25% over company's older designs.

Thomas & Betts Co, 2838 Butler, Elizabeth, New Jersey

Electronic Recorder

1074 • New recorder is available in both potentiometer, pyrometer and resistance thermometer bridge types. Instrument is suitable for many different temperature ranges from −100 to + 3000 F, manufacturer states. It is also claimed to be suitable for recording humidity, solution conductivity, speed, pH, dc current or voltage, power, strain, or other measurements that can be converted to a change in resistance or dc millivoltage.

Instrument records on a 12 in. circular chart, and pointer is visible at 50 ft.

Thermo Electric Co, Inc, Fair Lawn, New Jersey

Mild Steel Electrode

1075 • Improved E6010 electrode *Airco* 78E, is said to offer depe penetration without undercutting, a minimum of spatter, and uniform weld deposits without fingernailing.

The 78E is recommended for fabricating mild steel plate and rolled sections or castings, fired and unfired pressure vessels, structural frames, pipe lines and all classes of marine work. "Pocket Guide to Electrodes" available on request to company.

Air Reduction Sales Co, 60 E 42nd St, New York 17, N. Y.

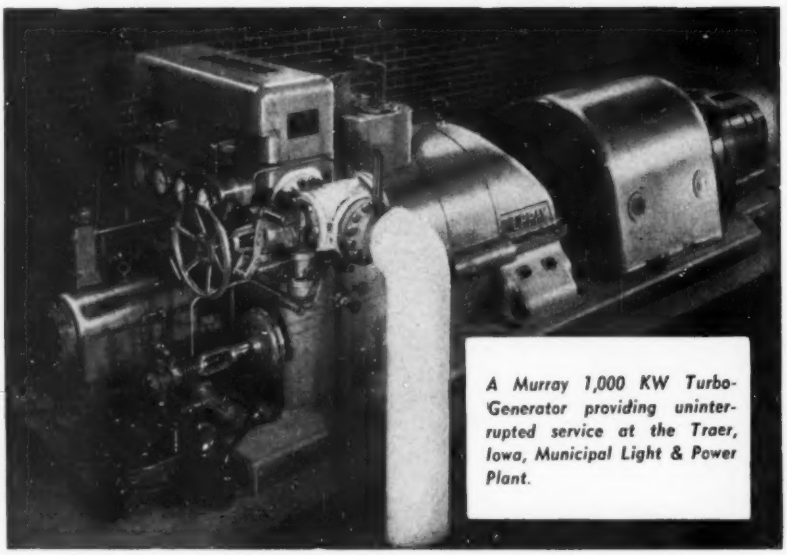
curious?

Furnace Operators! A little curiosity about this amazing FREE service can pay big dividends. *It's the Cities Service Heat Prover*... "not an instrument you buy, but a service we supply!" This unique instrument offers rapid, continuous sampling . . . simultaneous reading and direct measurement of oxygen and combustibles . . . and easy portability. We maintain the Heat Prover free of charge! It's not a curious fact that so many furnace operations have been bettered with the Heat Prover. Find out how and why the Heat Prover can increase furnace productivity for you. Call or write your nearest Cities Service Office or write Cities Service Oil Company, Dept. J 16, Sixty Wall Tower, New York City 5, N.Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

Murray Turbines



A Murray 1,000 KW Turbo-Generator providing uninterrupted service at the Traer, Iowa, Municipal Light & Power Plant.

● A typical, modern, small public utility is the Municipal Light and Power Plant at Traer, Iowa. This plant supplies water, steam heat and electric power to the community and surrounding countryside. The Murray turbo-generator pictured above carries the full electrical load of the plant and supplies the steam for heating by automatic extraction at 10# gauge pressure.

The simplified design and rugged construction of this and all MURRAY turbines particularly adapt them to this or any other drive where long life, reliability and low operating costs are a *must*.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

More EQUIPMENT NEWS

Begins on page 176

Recording Oscillograph

1076 • Seven-element automatic oscillograph, Type PM-13, records power system disturbances and photographically records preselected magnitudes, wave shapes and phase relations.

The unit has seven permanent magnetic, fluid-damped galvanometers with a separate shunt and resistor unit for adapting them to current or voltage measurements.

Unit can be started automatically by overcurrent in ¼ cycle, and stopped after a predetermined interval or after the fault has cleared, manufacturer states. The data permits engineer to visualize system behavior under fault conditions, sequence involved in clearing the faults, and the time required to re-establish steady-state conditions. Bulletin GEC-396.

General Electric Co, Schenectady 5, New York

Sulfur Recorder

1077 • *Titrilog* quantitatively records sulfur compounds like hydrogen sulfide, sulfur dioxide, etc in concentrations as low as 0.1 ppm or 0.005 grains per 100 cubic ft, manufacturer states. Certain compounds of specific interest may be separately determined.

The unit records concentration of sulfur compounds in gas streams or atmosphere, may be used for air pollution control, or, in the natural gas industry, for evaluating and treating natural gases to remove hydrogen sulfide, and in odorization practices.

Two models available: portable, model 26-103; and cabinet, model 26-102. Bulletin CEC 1810B.

Consolidated Engineering Corp, 300 N Sierra Madre Villa, Pasadena 15, Calif.

Insulating Varnish

1078 • GE 9615 insulating varnish is said to be suitable as a tough, flexible insulation on coils operating continuously at 150 C and for short periods at 175 C. Manufacturer claims it bonds well to electrical components, Mylar and silicone-glass insulations. The new varnish was developed for heavy-duty electrical equipment with insulation temperature requirements greater than Class A. It is also suggested as the binder for cotton or glass served wire and as a finish coat over conventional Class H insulation to improve the bond, facilitate cleaning and provide additional moisture protection.

Varnish has a dielectric strength of 1200 v per mil wet, 2200 v per mil dry.

General Electric Co, Chemical Materials Dept, Pittsfield, Mass.

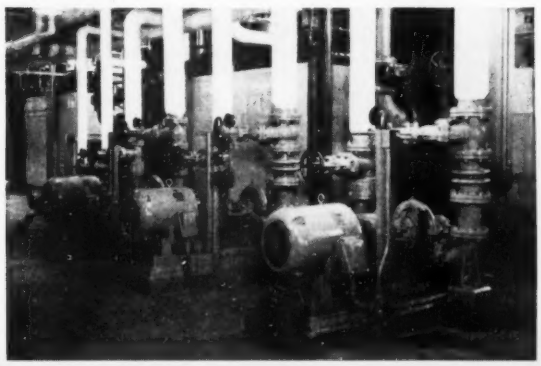
Printed Acetate Drawings

1079 • Acetate sheets printed with standard notes, revision boxes, bills of material, standard wiring diagrams, etc, save hand lettering and repetitive drawing. Draftsman applies the sheets, known as *Stanpats*, to the rear of tracing, by merely pressing them into place. Transparent adhesive locks to the tracing by bonding to the paper or cloth fibers.

Stanpat, Whitestone, New York

Oh, I see

OIC VALVES at work in the power plant at Ford Motor Company.



THE CLEVELAND PLANT of the Ford Motor Company, showing the engine plant, foundry and power plant.

...they're using our valves at FORD

Ford cars are an example of true manufacturing efficiency. Ford buys only that equipment which can be relied upon to maintain or increase such efficiency.

OIC's Long Line of valves meets Ford's exacting specifications. They're used here on basic facilities and main piping systems for water, steam and air. Because they're precisely engineered for long, trouble-free service, OIC Valves can help you achieve maximum efficiency in control of flow. Write for catalog information or engineering assistance in selecting and applying valves.

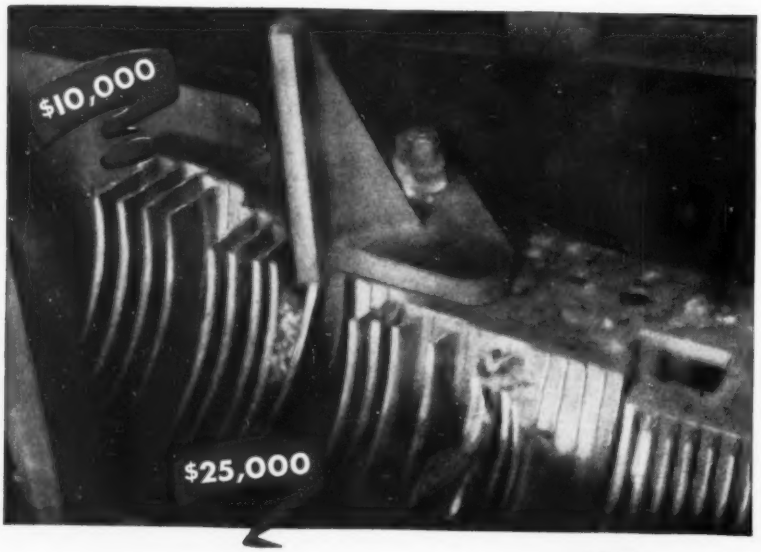
THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC FOUNDED 1883

VALVES | **FORGED & CAST STEEL, IRON & BRONZE, LUBRICATED PLUG VALVES**

How Much Would it Cost You...

$5,000

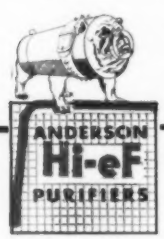


If This Happened to Your TURBINE

$50,000

● Replacement of turbines is costly . . . even in the case of minor repairs, labor, parts and downtime costs soon mount up. To go under the assumption that the installation of superheaters in a boiler eliminates the need for purifier protection is dangerous. Particularly during startup and periods of faulty boiler operation such as occurred above, all turbines should have Hi-eF Purifier protection. These high efficiency units assure you of the delivery of cleaner, drier steam of better than 99.95% quality.

Write, wire or phone today for information on protecting your steam-using equipment and boilers with Hi-eF Purifier.



WATCHDOGS OF STEAM • AIR • GAS • VAPOR
Pipelines and Equipment

THE V. D. ANDERSON COMPANY
1934 W. 96th Street – Cleveland 2, Ohio
Please send information on the following types of purifiers:

☐ Line Type ☐ Internal ☐ Receiver

Name..... Title.....
Address.....
City.....
State.....

BY THE MAKERS OF SUPER-SILVERTOP STEAM TRAPS

More PLANT PROBLEMS

Continued from page 154

HOLES or thin spots in fuel bed cause *HS's* trouble. Coal segregation or clinker formation on side walls leads to thin spots. Clinkers sweep incoming coal away from the ledge plates, leaving a bare or thin spot in the grate.

Cold air entering the furnace through these holes cools the hotter furnace gases, setting up vibrations of sufficient frequency to be audible. This is the source of the low-pitched drumming sound *HS* hears. Closing boiler damper changes the air flow. This, in turn, changes the frequency of vibration, and the noise stops.

To overcome these difficulties: (1) Keep size consist of coal reasonably constant. (2) Reduce maximum size of coal to 1 or ¾ in. (3) Carry a thicker fuel bed. Incidentally, I doubt if the vibration is serious, but it is annoying and affects the operators' peace of mind.

E D Benton
Ohio Coal Association, Cleveland, Ohio

UNSTABLE IGNITION, a common problem with chain-grate stokers, causes this trouble. Look for improper coal distribution or unequal thickness of the fuel bed. Another cause may be insufficient air for combustion if the air reaching this boiler is the "remainder" after the other three units are supplied.

Check the coal feeder to see that it distributes the fuel evenly. *HS* may find it helpful to increase duct size so more air will flow to this boiler. Also, the arch may be moved farther from the front of the unit. This will increase the furnace volume to give more efficient combustion.

A J Breugelmans *New York, N. Y.*

UNEQUAL water circulation may cause this vibration. Steam pockets within the tubes lead to violent water turbulence. Radiant-heat transfer to the tubes is uneven when water circulation is poor. *HS* can get improved circulation by turbining, flushing and washing all tubes. Wash drums, too.

L N King *Himrod, N. Y.*

CHECK atmospheric data every time boiler vibrates. Record wind direction, velocity, barometric pressure and temperature. *HS* may find some correlation between weather conditions and boiler vibration. Then change breeching and uptakes to cure the trouble.

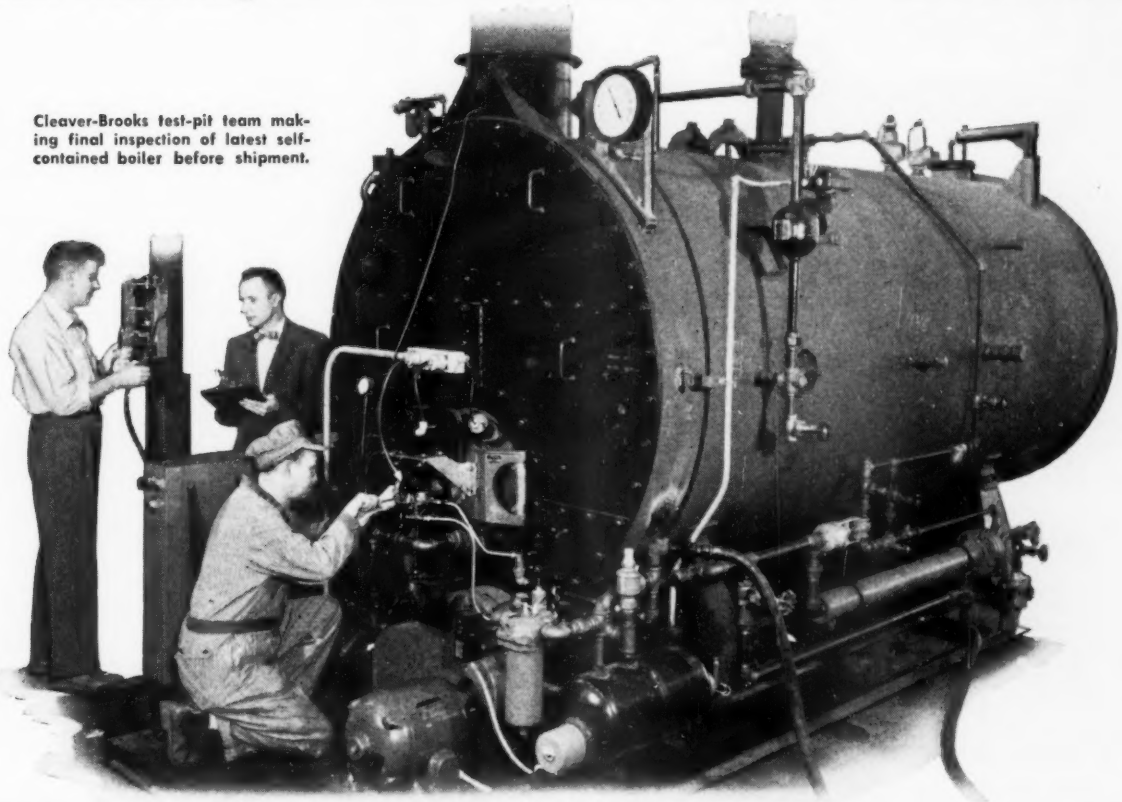
A M Palmer *Brooklyn, N.Y.*

CHECK DRAFT over the fire to see if sufficient air is reaching the fuel.

George Avant *Wilmington, N.C.*

their counterpart "Test-Pilots" have at Cleaver-Brooks

Cleaver-Brooks test-pit team making final inspection of latest self-contained boiler before shipment.



HIGH SCORES . . . on factory and on-job tests guarantee greatest return from boiler investment

When test pilots give the familiar "O.K." — that's the sign of proven performance. It's the same with boilers in the Cleaver-Brooks plant. Only after accurate, thorough inspection and testing under actual operating conditions do boilers get the final "O.K." from experienced test engineers. That's why you get guaranteed 80% efficiency from your Cleaver-Brooks boiler.

A record of this test is available to every buyer on request. In fact, you as a buyer, consultant, or contractor are invited to witness the actual test on your Cleaver-Brooks boiler before shipment.

And further, Cleaver-Brooks boilers are placed in operation at the job site by factory service engineers who check installation, train your operators and make complete and detailed field tests.

So, when you buy a boiler, insist on factory tests as well as field service tests by qualified engineers. There is no better way of insuring yourself of the very best value money can buy and the greatest return from your boiler investment. Look to Cleaver-Brooks, the leader in the "Packaged" Boiler field for two decades. Write today for latest Catalog AD-100.

Available for oil, gas and combination oil/gas firing.

CLEAVER-BROOKS COMPANY
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Milwaukee 12, Wisconsin, U.S.A.

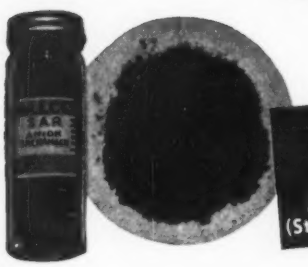
Cleaver-Brooks

Originators of the Self-Contained Boiler

BOILERS — STEAM OR HOT WATER — FOR HEATING AND PROCESSING IN SIZES FROM 15 TO 500 HP, 15 TO 250 PSI

COMBINATION for HIGH-CAPACITY DEIONIZATION

Nalcite HCR®
(Cation Exchange Resin)



Nalcite SAR
(Strongly Basic Anion Exchange Resin)

THE use of Nalcite HCR and Nalcite SAR for complete, high-capacity deionization of water and process liquids has frequently proved a great time- and money-saving advantage over other deionization methods and materials. Best way to judge whether these modern chemical tools can be useful to you is to get full technical data as described below, and decide for yourself. Write today for your copies of Bulletins 57 and 58.

TECHNICAL BULLETINS on Nalcite HCR and Nalcite SAR give complete physical and chemical characteristics along with operation and performance data. Ask for Bulletin 57 (Nalcite SAR) and Bulletin 58 (Nalcite HCR). No obligation.

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Nalco® PRODUCTS

When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

MARMADUKE

Continued from page 164

the two hour test heat-run, she really acted up. At half load, she showed a terrific hunt in the governor. The load was furnished by a salt water rheostat as a phantom load, which gave a unity power factor. So naturally there could be no problem of inductance.

"The large contracting firm had sent over a bright young electrical engineer as test electrician, but after a few days he threw in the sponge. The contractor then called in the turbine manufacturer, who sent out two of their governor specialists. Those two birds checked their equipment for a couple of days, then gave up, blaming the electrical end.

"By this time the sugar mill superintendent had blown a gasket or two, because he had been promised those turbines days ago. So the contractor sent over another of his high powered trouble shooters.

"For two days, eight hours a day, this book engineer tried everything. But soon as he put the load on No. 2, that governor went into a wild hunt, as before—first wide open, then shut off, then wide open again. She kept that up each time until the overspeed trip let go. During this time every meter on the switchboard was in a wild swing.

"By now the big shots from the sugar mill were in the plant raising hell with the contractor. That was when I walked in and sat down to take it all in. The contractor just stood there, shaking his head while his expert was running around in circles, trying first one thing then another. And No. 2 whined all the while like a heartbroken banshee.

"During this time I had kept my main-stop closed for almost an hour, and the stored up pressure was about to blow my safeties. So I navigated over to the fog-bound group and let go a blast.

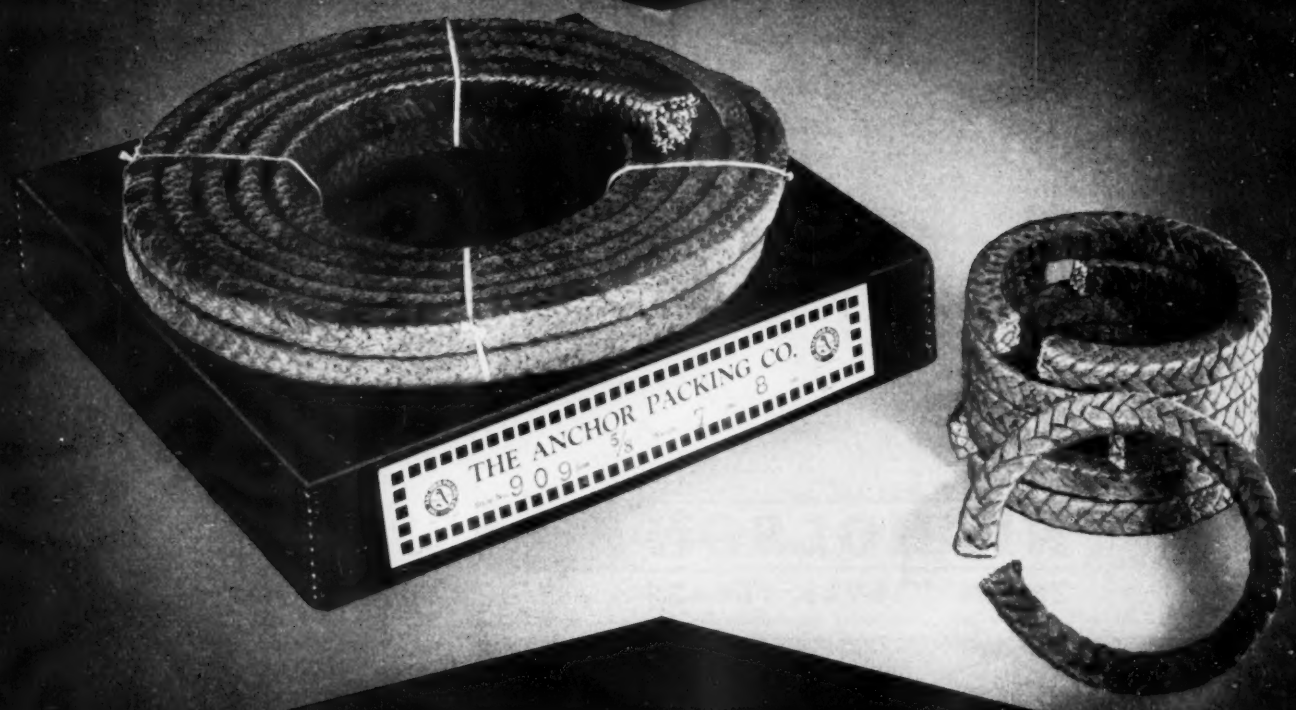
"'Look here,' I started, trying to be as diplomatic as I could. 'When it comes to electricity, you guys wouldn't make a pimple on the stern end of a third class electrician!'

"'Who in hell are *you* and who asked *you* for advice,' yelled the contractor, getting his voltage up and arcing at the mouth.

"'Hello, Marmaduke,' says Jim Gillispi, surprised to see me. He slapped me on the back and announced to the startled men, 'Gentlemen, this is Mr. Surfaceblow, my old shipmate and the best marine chief engineer I've ever had the pleasure to sail with—and I've sailed with a lot of them.'

"'The trouble with you knuckleheads,' I cut in real politely, 'is that you're bailing out a sinking ship instead of plugging up the leak. I'll bet a month's pay against a pound of ex-

ANKORITE 909



A PACKING SUITABLE FOR TEMPERATURES UP TO 500° F.

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Ankorite 909 is a square braided asbestos packing, extremely soft and pliable, suitable for any packing purpose on temperatures up to 500° F. It contains no graphite and is lubricated with a high temperature white lubricant, making it adaptable to any food-handling apparatus.

Ankorite 909 comes in ring and coil form and is ideal for packing against gasoline and other hydrocarbon solvents, on stainless steel parts, and food-handling machinery.

THE ANCHOR PACKING COMPANY

GENERAL OFFICES: PHILADELPHIA, PA.
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FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

Solve Sludge Problem with Nicholson's

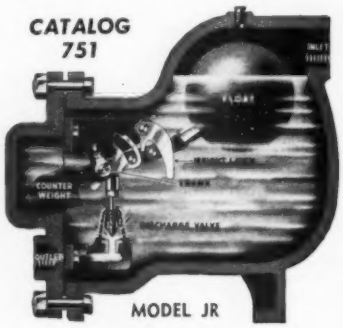
New AIR TRAPS

With the introduction of an exclusive new oil-eliminating feature, Nicholson air traps now enable you to enjoy the advantages of the positive intermittent action of a float-operated air trap without the common problem of oil congealing on the mechanism and impeding or stopping its action. Other features of Nicholson air traps:

1) No air-wasting vent, such as is in all inverted bucket traps.
2) Positive water seal of valve.
3) Large orifice keeps valve clean, preventing blow-through.

Three types; pressures to 1500 lbs. These weight-operated traps also for steam.

CATALOG 751



MODEL JR

125 Oregon St., Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

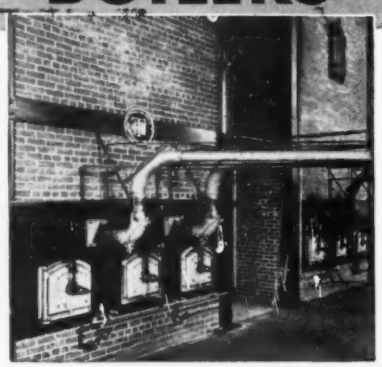
TRAPS · VALVES · FLOATS

TITUSVILLE IRON WORKS CO TITUSVILLE, PA.

3-Drum WATER TUBE BOILERS

"Standard of the Industry" FOR EFFICIENT STEAM GENERATION

Schools and institutions demanding low cost boiler operation with maximum steam output are an important part of the long list of Titusville 3-Drum Water Tube Boiler users in many different fields. May we consult on your coming needs?



State Teachers College, Edinboro, Pa.

Two Titusville TDL Boilers, 160 lb., pneumatic spreader stokers. Contractor: Dravo Corporation, Pittsburgh, Pa.

THE TITUSVILLE IRON WORKS COMPANY

a division of Struthers Wells TITUSVILLE, PENNA.

Representatives in Principal Cities

MARMADUKE

Continued from page 164

haust steam that I can have that generator straightened out by lunch time.'

"'Where did you study electricity and what kind of engineering degree do you hold?' came back the contractor in defense.

"'Never mind about the book stuff,' I answered. 'If it's a slide rule engineer you want, you already have one in your expert. But just to satisfy you, I can pump one of those things as well as the next guy.' With that I yanked a slide rule out of the superintendent's shirt pocket and started to give it merry hell.

"'OK,'" yells the contractor suddenly. 'Straighten her out and I'll make it worth your while.'

"I hung up my coat in Jim's office, rolled up my sleeves and went into high gear. Those guys were skeptical, and they kept a weather eye on every move I made.

"First I watched the gland seal steam. I had noticed that it bounced from zero to 20 psi at a full steam head on a 27-in. vacuum. That convinced me that it was a load problem.

"The turbine was doing all she was built for and more, but she had no control. I checked and found the water stable in the rheostat. Next I opened the voltage regulator. She was hunting, just as badly as the governor.

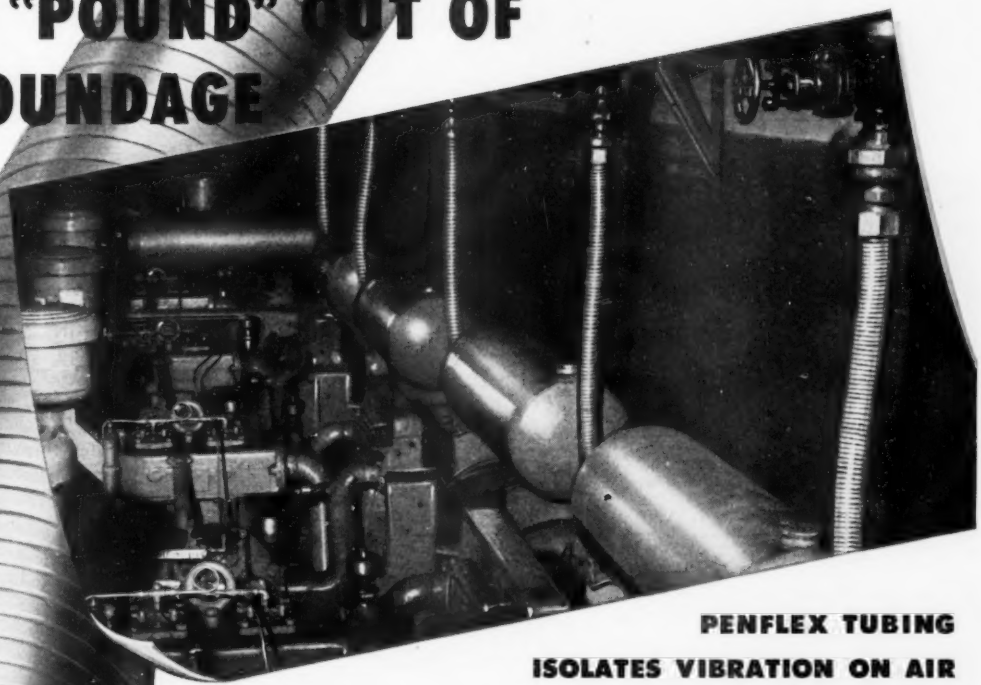
"I took the load off the generator while she was still up to speed. Then everything settled down to a steady frequency of 60 cycles. I shut the unit down and checked all electrical connections from the dc field right back through the field rheostat to the voltage regulator and exciter. But they were just as true and correct as the steam and vacuum. So I knew I'd have to look elsewhere for the answer.

"By this time I wondered if I hadn't stuck my bowsprit out a little too far by tackling this job. But I moved to the exciter. It had been putting out normal voltage and current, but I checked her field residual magnetism anyway. And there was the trouble. The field residual magnetism was reversed.

"After some tracking down, I found the reversal had been caused by a shop test before the exciter was delivered back to the plant. That would—and did—reverse the exciter voltmeter and ammeter. I also learned that Jim's electrician found that trouble first and corrected it by reversing the meter leads. Only trouble was that he kept his mouth shut without telling the contractor.

"So of course meters gave correct readings but polarity to voltage regulator was still reversed. That of course put a reversed polarity into the damping

TAKES "POUND" OUT OF AIR POUNDAGE



PENFLEX TUBING ISOLATES VIBRATION ON AIR COMPRESSOR LINES... PUTS PUR-R-R IN AIR POWER

The "pound" and roar of eleven compressors is no longer transmitted along all of the air lines and throughout the surrounding building. Penflex Flexible Metallic Tubing has been installed on the exhaust and supply lines of the air compressors.

Penflex four-wall interlocked tubing is as tight as a pipe, but flexible. Its flexible durability allows the vibration to be "soaked up" in its many interlocking sections. Its toughness assures longer service under all operating conditions.

In the power field—on diesel exhausts and air intakes . . . fuel oil and starting lines . . . lubricating oil and water circulating lines . . . compressed air lines . . . and many other places where tubing is used—you'll find Penflex engineers ready and eager to help you solve your toughest tubing problems. Write today for your new fact book on flexible tubing.

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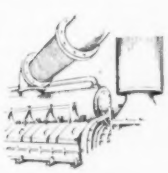
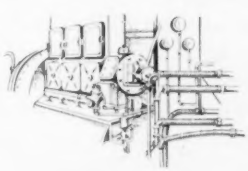




PENFLEX

HEART OF INDUSTRY'S LIFE LINES

DRY, FRESH AIR For a Supersonic WIND TUNNEL

● New and improved, this NIAGARA METHOD that effectively dries outdoor air for a wind tunnel used for testing at supersonic speed, can be trusted to give you the best air conditions for your purpose:

- to dry your materials or products
- to prevent condensation or moisture damage
- to protect your moisture-sensitive processes
- to give you an atmosphere in which your product can be packaged or stored safely.
- to give you exactly the right atmospheric conditions for testing materials
- to put "fresh air" back into your air conditioning, increasing its capacity and effectiveness

The Niagara "fresh air" Method removes the excess moisture from outdoor air by contact with an absorbent liquid in a spray chamber. The liquid contact temperature and the absorbent concentration, both controlled thermostatically, determine the amount of moisture in the conditioned air. Heating or cooling the air is a separate function. Therefore, you can easily and inexpensively have a precisely controlled condition without the use of moisture sensitive instruments.

The Niagara Absorbent Spray Method is noted for solving the really difficult problems of air conditioning. Write for complete information.

NIAGARA BLOWER COMPANY

Over 35 Years' Service in Industrial Air Engineering

Dept. P, 405 Lexington Ave. New York 17, N.Y.

Field Engineers in Principal Cities of U. S. and Canada

MARMADUKE

Continued from page 164

transformer of the voltage regulator, and caused a hunt instead of damping. So reduced voltage to over voltage had caused the load to fluctuate. And that brave little governor was trying to stay abreast of it all. It was a plain battle of the voltage regulator against the governor.

"Thirty minutes after I started, the generator was on the line. And she passed her test without a hitch. The contractor slipped me a check that paid for some high living during that seaman's strike. And he offered me a trouble-shooter's job anytime I got caught up with my social obligations with the fair sex in the many ports around the world." S.M.E.

Rubber-jacketed electric power cable for Arctic use has been developed by the Engineer Research and Development Laboratories, Fort Belvoir, Virginia. The new cable, also adaptable to tropic conditions, remains flexible at temperatures as low as —65 F.

Unlike standard cables which act like springs when frozen, it can be uncoiled without snapping and it does not become brittle or stiff at low temperatures. Known as GR-S 1023, the cable is composed of 87 parts butadiene and 13 parts styrene combined at 122 F.

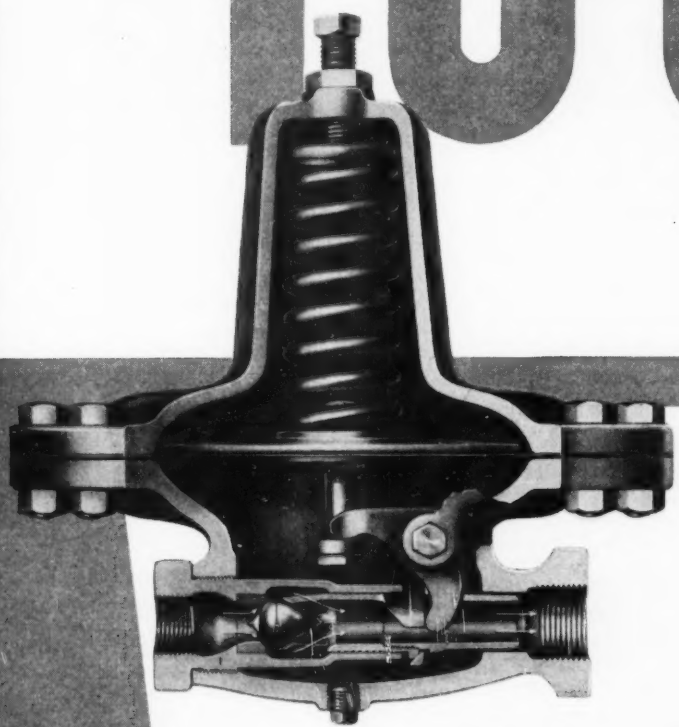
Research is continuing to obtain improved electrical, physical, chemical and all-weather properties of new cables. The goal is a cable that will combine all-weather characteristics with additional resistance to ozone and oil.

Britain's first gas-turbine electricity generator for supplying power to the national grid has been attracting many overseas experts during the last six months. The unit, installed at Trafford Power station near Manchester, has been running satisfactorily without major modifications. However, it was stripped down recently to correct a number of faults caused by uneven expansion of metals exposed to the very high temperatures.

Tests are to begin shortly using a grade of fuel cheaper than the aviation-type kerosene burned for initial running tests. Medium-grade bunker oil will be used first and quality will be reduced until the cheapest fuel for satisfactory running is found. Further tests will determine minimum time required to run cold set up to full load. So far this has taken an hour but this time is expected to be cut to ten minutes in the near future.

Caterpillar Tractor Co is planning construction of a new plant for producing motor graders and industrial wheel tractors. Although location is undetermined, the new plant will occupy 700,000 sq ft and will be completed by 1956. This expansion will permit a broadened crawler tractor and diesel engine program at the Peoria plant.

TYPE 1000 VALVE



Any product of quality should be dependable when *ordinary* products fail. Sudden pressure fluctuations, dirt, scale and viscous matter prove "fatal" to ordinary pressure reducing valves.

The CASH STANDARD TYPE 1000 VALVE however, is designed to operate with complete dependability under the most difficult and unusual circumstances. Many of these units have been in service over 10 years and have never been taken "out of the line."

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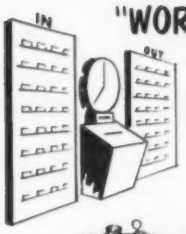
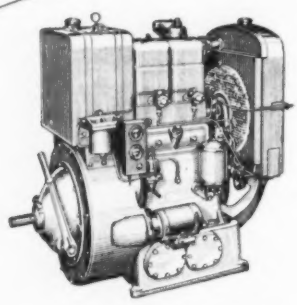
CASH STANDARD **DECATUR, ILLINOIS**

A. W. CASH COMPANY

There's no limit to "WORKING HOURS" for a NORDBERG DIESEL!





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No "9 to 5" routine for Nordberg "4FS" series Diesel engines . . . they're built to stay on the job around the clock—day in and day out. Using sturdy, heavy duty construction throughout, these conservatively rated units are your best buy for the toughest kind of power jobs . . . in construction, oil field, irrigation, power plants, marine service and scores of other power requirements.

Built in 1, 2 and 3-cylinder models, these reliable, low cost Nordberg Diesels are available as power units in sizes from 10 to 45 hp; as generator sets from 6 to 30 kw; and as pumping units in capacities from 200 to 3,000 gpm at 15 to 240 ft. total head.

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Company Name _____

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4-153

More TECHNICAL BRIEFS

Begins on page 172

A large scale air-flow model was built and the flow problem was analyzed. Various means for making the air-flow stable and uniform were developed and tried. It was found that a set of four perforated plates, each with 40 percent through area for passage of the air and suitably arranged at the model inlet, provided a stable and even air flow.

Such distributor plates were installed in the precipitators in the field and performance improved to the required degree. *APCA Paper. No number.*

Directions for ordering papers on p 174

Dust Emissions from Small Spreader-Stoker-Fired Boilers. *By E J Boer, Bituminous Coal Research and C W Porterfield, Pocahontas Fuel Co.*

The increased emphasis on the need for reducing air pollution from all sources has raised a greater interest in the problem of collecting fly ash and cinders from coal-fired boilers—particularly in those plants where spreader stokers are used.

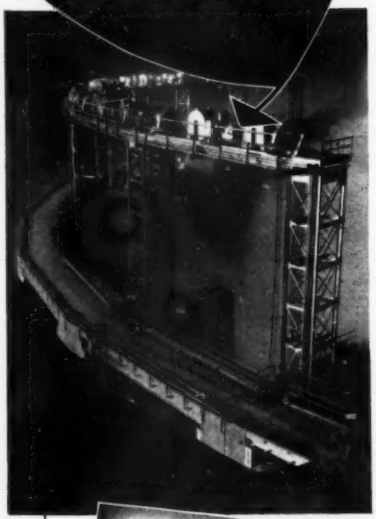
Tests were conducted on four small spreader-stoker-fired plants to determine dust emissions at the boiler outlet under various test conditions. The results indicate the dust emissions increase when (1) the proportion of extreme fines in the coal increases, (2) the rate of heat release increases, (3) the excess air increases, and (4) on-off controls are used in place of modulating controls. The results of these tests, reported as dust loadings at the boiler outlet, are helpful in selecting dust collectors that may be used to reduce the final stack emissions to conform with air-pollution-control ordinances.

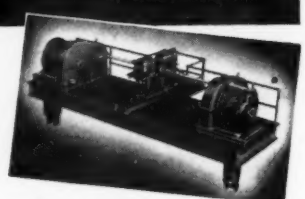
After these tests had been completed, data on emissions from two additional plants were made available through the courtesy of Harry Ballman, Smoke Regulation Engineer of the City of Columbus and of Joseph Breslove, Jr, of the Breslove Separator Company. In many respects these data verify the results of the earlier tests and are presented in conjunction with the results of the tests sponsored by Bituminous Coal Research, Inc. *ASME Paper No. 53-S-26.*

Economic Factors of Atmospheric Corrosion vs Protection. *By Clarence C Harvey, Ethyl Corp.*

Economic appraisal of atmospheric corrosion loss of metal demonstrates that, in most environments, painting is not justifiable solely from the protection standpoint. More economical protection can be provided by the use of an exterior corrosion allowance. However, painting is indicated to be justified when both

MURCO Spillway GATE HOISTS





8 MURCO Spillway Gate Hoists, 125 ton capacity, installed by the Washington Water Power Co., Cabinet Gorge Project, Clark Fork River, Idaho.

DESIGNED and BUILT TO MEET ALL REQUIREMENTS for any Size Power Dam

Murray Gate Hoists are designed and built in a wide range of capacities from less than one ton to over one hundred tons . . . from the smallest hand operated to the largest motor operated gate hoist. In over 50 years of designing and building gate hoists, we have developed designs for many gate hoist problems. We may have designs and patterns to fit your special requirements. In planning gates or gate hoists, we suggest you write us before your over-all plans are complete . . . it may save time and money. We also build gate hoists to fit your plans and specifications.

Write for complete information and Engineering Department recommendations

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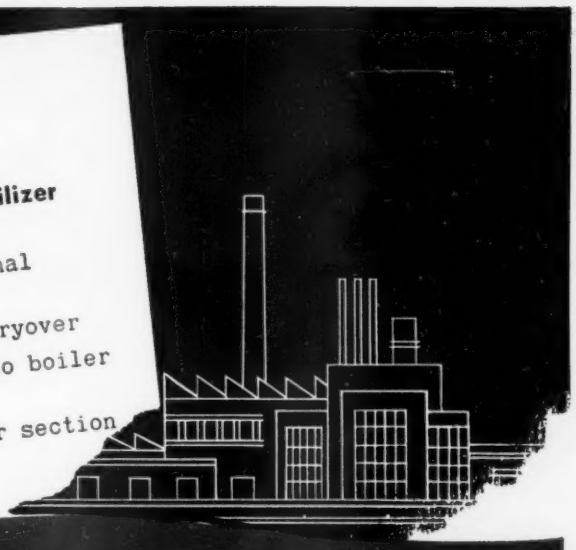
Antifoam, Sludge Conditioner and Stabilizer

Used in conjunction with conventional inorganic water treatment to:

a) Provide protection against carryover
b) Prevent sludge from adhering to boiler metal surfaces
c) Prevent deposits in pre-boiler section



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Anything other than dry steam going over from the boiler may lead to difficulties in boiler water systems. Drew Boiler Water Treatment includes highly effective products such as Drew Organic U-14-L for prevention of carryover.

A large food manufacturer in the mid-west was troubled with excessive carryover. Drew Organic U-14-L was recommended after a thorough analysis. It not only stopped the carryover, but also cleared up sludge adherence, which had long been a problem.

To prevent or eliminate industrial water problems in your plant, you'll get results faster and more economically with this Drew program:

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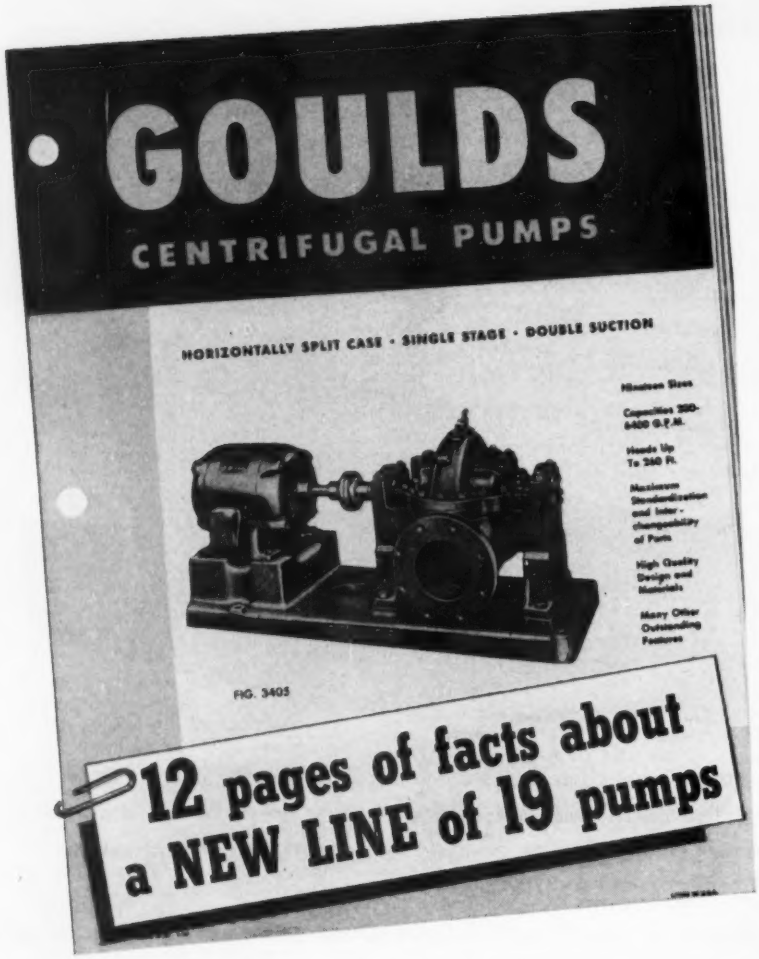
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FIG. 3405
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The Fig. 3405 carries interchangeability of parts far beyond anything we've been able to do before. Only three shaft and rotating parts assemblies (exclusive of impellers and wearing rings) provide for 19 pump sizes.

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We've come as close as modern design and materials allow to putting into this new pump what our industrial customers have told us they want. The 12-page illustrated bulletin tells you all about it. We'll be glad to send you a copy.

To get a copy of Bulletin 721.6, get in touch with the nearest Goulds representative or just fill in the coupon, pin it to your letterhead and mail it to us at your convenience.

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More TECHNICAL BRIEFS

Begins on page 172

the decorative and protective functions are considered. For most large industries the decorative function of paint plays a more important role in maintaining good employee and community relations than is recognized normally.

Graphic analysis of long-term paint economics indicates that maintenance of coatings in their best condition usually costs less than allowing them to deteriorate before repainting. On-site atmospheric corrosion data and careful analyses of painting practices are recommended as maintenance dollar savers.

Atmospheric corrosion varies widely with specific environment. At Frodingham, England, the corrosion of iron coupons was approximately 100 times as high as at Khartoum, Egypt. What were the factors responsible? First, we can say that moisture plays a very important role. The percentage of time iron or steel is wet by dew or rain is usually conceded to be one of the controlling factors. At Khartoum, where the rainfall averages about 3 in. per year and where the relative humidity is about 30 per cent, unprotected steel is said to retain a polish for as long as a year when exposed outdoors. This is understandable, but most refineries are not located so favorably.

The second—and probably the most significant—factor that controls atmospheric corrosion is air contamination. The effect of air-borne salt spray is demonstrated by the data for Kure Beach, N. C., and for Congella, South Africa. The effect of sulfur dioxide, carbon particles and other industrial and urban atmospheric contaminants is illustrated by the data for Pittsburgh, Pa., and for Sheffield and Frodingham, England. Atmospheric corrosion is highest in such environments.

Third: Temperature has a small, although significant, effect on atmospheric corrosion. In arctic regions such as Abisco, Sweden, corrosion is slight. Even though relative humidity may be high at such locations, absolute humidity is low. This hinders corrosion. Also corrosion, like other chemical reactions, is slowed down by low temperatures.

There are many other factors which influence atmospheric corrosion. Larrabee and others have pointed out that the precise composition of the metal is significant. *API Paper, no number.*

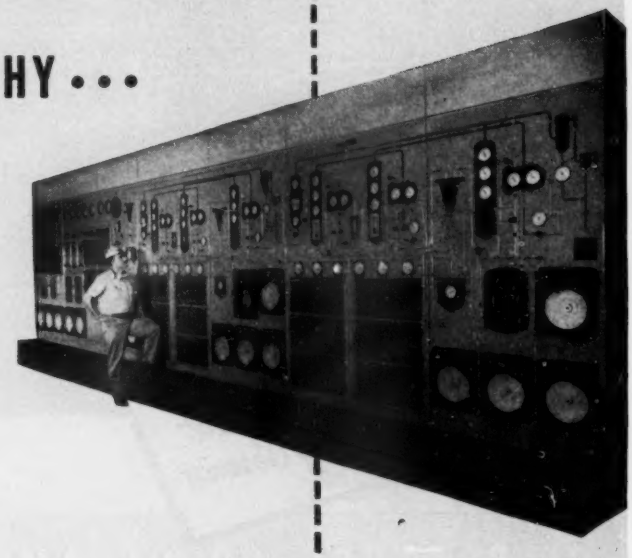
Cooling Towers

Deterioration of Redwood Cooling Towers. *By Roy V Comeaux, Humble Oil and Refining Co.*

The mist eliminator section of a redwood cooling tower failed at Humble's

6 REASONS WHY . . .

PANELLIT is the largest builder of process control panels



1 **SPECIALIZED ENGINEERING . .** combining instrumentation and process experience, PANELLIT provides sound and economical engineering as a part of their service.

2 **ADVANCED STANDARDS OF CONSTRUCTION . . .** have distinguished PANELLIT in every detail of structure, finish, piping, terminal arrangements and serviceable behind-the-panel layouts.

3 **PIONEERING CONCEPTS OF INSTRUMENTATION . . .** the graphic control panel, miniature instrumentation, unitized annunciator systems, scanning and monitoring devices . . . all have been closely associated with PANELLIT.

4 **ORGANIZATIONAL FLEXIBILITY . . .** Few process control panels are ever shipped without changes. When "change orders" are received, PANELLIT moves quickly to carry them out . . . without confusion . . . without delay. Where others take weeks, PANELLIT takes hours.

5 **THE ONE MAN PLAN . . .** makes PANELLIT easy to work with. One project engineer stays with your job. There are no "pass along instructions" or "round about authority".

6 **INFORMATION SYSTEMS . . .** an advanced PANELLIT concept of the control panel has resulted in better process control. An *information system* filters information for the operator to know . . . and presents it in a manner that he may act quickly and instinctively. *Write for complete information.*

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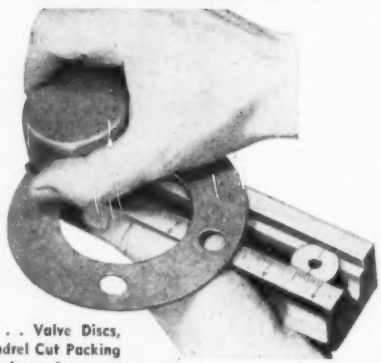

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Superheat Sheet Packing . . . Oil Proof Sheet Packing . . . Red Rubber Sheet Packing . . . Diaphragm Sheet Packing . . . Cloth Inserted Sheet Packing

More TECHNICAL BRIEFS

Begins on page 172

Baytown refinery after only six years of service. The failure resulted primarily from attack by wood-destroying fungi. It was found that this attack was occurring in essentially all of the Baytown towers, and also that the continuously flooded members were undergoing direct attack by chemicals. Complete failures of cooling towers have occurred in 11 to 18 years; the average life of the fill or packing has been only 11.5 years. Similar experience at other plants resulted in the initiation of a number of studies for the purpose of mitigating the problem. The available information is presented in this paper along with fundamental background material as a basis for the development of firm recommendations for the design, operation, and maintenance of cooling towers.

The factors which affect the rate of chemical attack are alkalinity, temperature and severity of chlorination. The factors which affect the rate of fungal attack include air, water, food and temperature conditions. The two forms of attack are not entirely independent; both have been observed to predominate on the same wood members at different periods as conditions in the towers change.

Directions for ordering papers on p 174

The rate of lignin removal from wood members appears to increase as alkalinity increases, as would be expected. Rapid delignification has been observed where chlorination has not been controlled within close limits. It is normal for the upper level of cooling-tower packing, which is exposed to the hot water, to require replacement before the packing in the lower levels; this is to be expected on the basis that there is usually a twofold increase in the rate of reaction for an 18 F increase in temperature. Minimum chemical attack can be expected when the pH is maintained below 7.5 and when chlorine requirements are minimized by proper sanitation practices.

Exposure of redwood to alkaline water also decreases its resistance to attack by fungi. Decay is negligible at wood temperatures above 105 F. When the wood members are saturated with water to the extent that air accessibility is limited, fungal attack is limited to the surfaces and the rate of attack is less critical. If water and temperature conditions are in favorable ranges for rapid fungal attack and cannot be modified, the use of pressure-treated wood to replace the decayed wood is a possible solution to the problem. The life of existing structures

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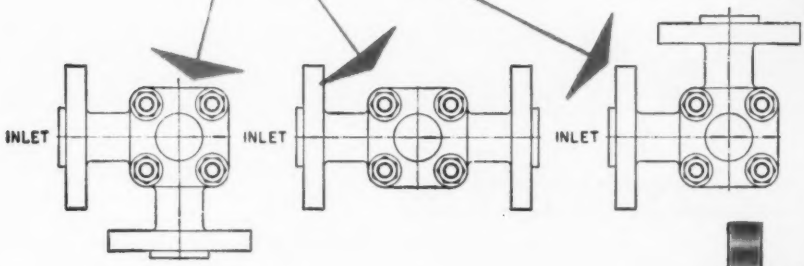
WITH Z BODY

CAN BE EASILY CONVERTED TO OFFSET ANGLE BODY



TYPE 567Z
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- Split flange construction with seat ring retained in center without threads.
- Inner Valve—Micro-Flute, Micro-Form or throttle plug type inner valve with solid stem connections.
- Sizes ½", ¾", 1", 1½" and 2".
- Materials: Regularly furnished in carbon steel or 18-8 stainless. Also available in bronze, Hastelloy and monel; other alloys on request.
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QUICK FACTS

- Extra wide bronze seats (Resist pitting and corrosion)
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More TECHNICAL BRIEFS

Begins on page 172

might be extended by the application of antiseptic compounds to minimize fungal attack. *API Paper, no number.*

Vessel Construction

Alternate Types of Vessel Construction —A Cost Comparison. *By I. E. Boberg and W R Fickett, Chicago Bridge and Iron Co.*

This paper deals briefly with some of the economic aspects of pressure-vessel design as influenced by a consideration of graphitization at elevated temperatures.

The occurrence of serious graphitization is not always predictable in advance. In many operations the financial loss which results from an enforced shutdown is so tremendous that a relatively unpredictable risk cannot be justified. As one operator remarked after the failure of an important vessel: "We could afford to build every such vessel of solid stainless, if by so doing we could avoid one shutdown."

That remark was figurative rather than literal, but it focuses attention on the trend toward the consideration of graphitization-resistant construction even at some increase in first cost. Such an increase might be insurance.

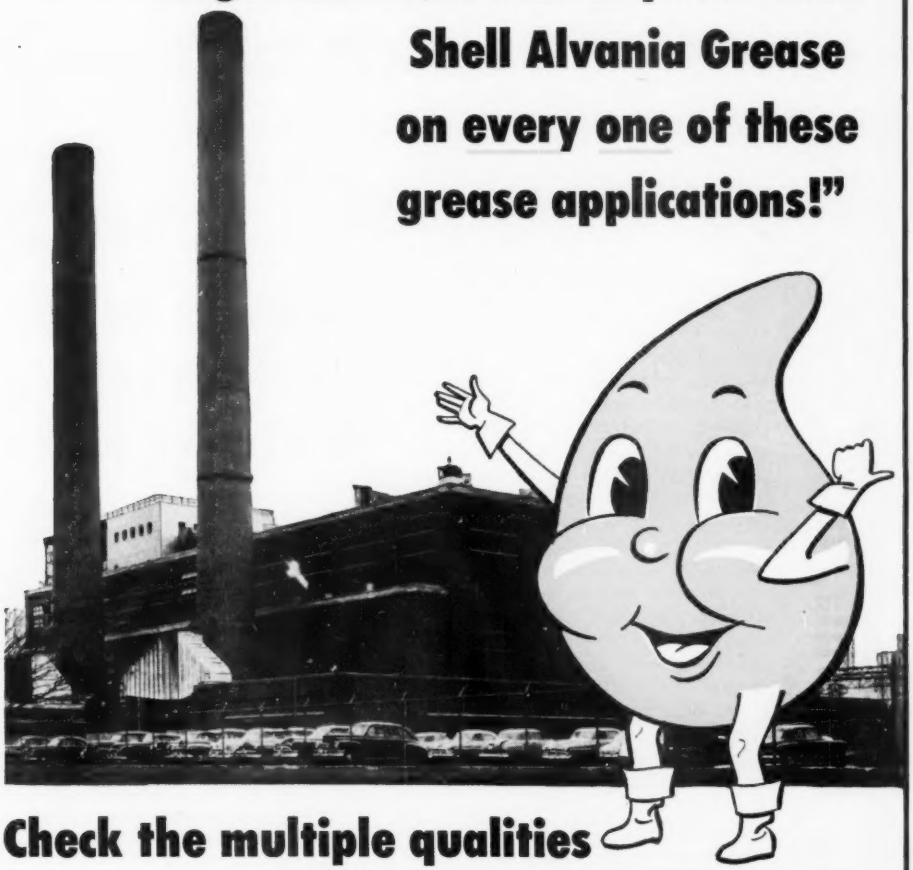
To shed some light on the subject of first cost, it was suggested that it would be helpful to develop comparative information on several available alternatives. The alternate types of construction were selected by the committee in charge of this program, and the sole purpose of this paper is to evaluate them. Discussion of the merits of one alternative over another is left for the papers of a more technical nature.

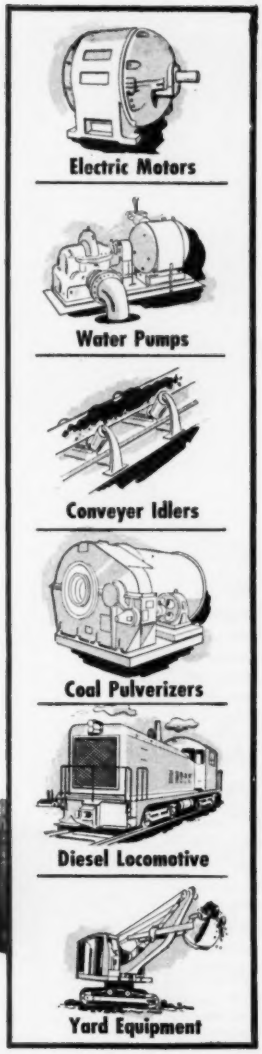
A first-cost investment in graphitization-resistant construction at some additional expense might, within limits, be considered as insurance. This paper evaluates first cost, as it applies to plate construction, of ASTM A 285, A 201, and graphitization-resistant A 301 steel at operating temperatures of 900 F, 950 F, and 1,000 F. Consideration is given to designs where internal insulation is employed—permitting design temperatures of not more than 650 F, as well as designs utilizing external insulation only and employing unit stresses prescribed for these elevated temperatures by API-ASME Code for the Design, Construction, Inspection, and Repair of Unfired Pressure Vessels for Petroleum Liquids and Gases.

Stated assumptions have been made relating to the cost of insulations, stress relief and radiographing. It should be

Directions for ordering papers on p 174

"Indianapolis Power & Light Company's large new White River plant uses Shell Alvania Grease on every one of these grease applications!"





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Shell Alvania Grease is effecting important improvements in plant maintenance and purchasing practice. In plant after plant, this one grease is replacing the many special purpose greases formerly used . . . for *every grease application in the plant!*

Look at these advantages:

1. Shell Alvania Grease flows *freely* in cold temperatures, yet will not run out of bearings under excessive heat.

2. Ideal for wet, humid applications . . . it resists water emulsification.

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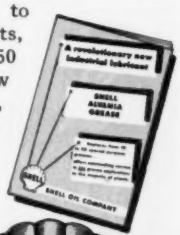

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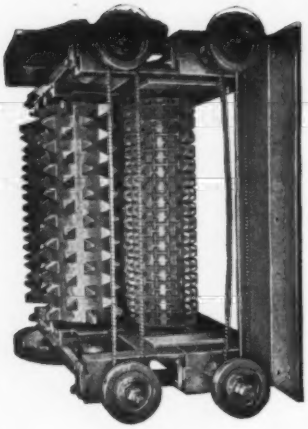

TWO STAGE — DOUBLE ADJUSTMENT

Crusher is pictured without hopper and sprocket guards, but is delivered complete.

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Two Stage CRUSHING IN ONE MACHINE!

The GUNDLACH "Two Stage" Coal Crusher incorporates two crushing stages in one machine and is designed to reduce RUN-OF-MINE to STOKER COAL in ONE operation. Compact design simplifies structural supports and installation. Rugged simple construction combined with engineering proved in the field makes this machine a profitable and reliable unit.

Fulfilling an urgent need in the industry, the GUNDLACH "Two Stage" Crusher has delivered over 85% usable stoker coal from an Illinois mine run lot.

MATERIAL SIZE CAN BE CHANGED WHILE MACHINE IS RUNNING

All Gundlach Crushers are equipped with Gundlach Patented Crushing rollers. (Pat. No. 2378540)

T. J. GUNDLACH Machine Co., Belleville, Ill.

More TECHNICAL BRIEFS

Begins on page 172

pointed out that these vary and have a marked effect on a cost comparison of this nature. *API Paper, no number.*

Oil Pumpability

The Pumpability of Fuel Oils. *By F Gill and R J Russell, Anglo-Iranian Oil Co, Ltd.*

Since the conclusion of World War I the demand for the gasoline and gas-oil fractions of crude has increased more rapidly than the demand for residual fuel oil. To meet this demand it has been necessary to cut more deeply into the crude, to take more of the vacuum gas oil fraction into saleable gas oil and so to leave heavier residues for the fuel oil market. The introduction of cracking, using as feedstock mainly the wax distillate fractions of crude, has resulted not only in a considerable increase in the bitumen available but also in the production of waxy residues for disposal in fuel oil blends. These factors have resulted in a steady increase over the last 30 years in the general level of the viscosity of residual fuel oils and have also led to a relaxation in the stringency with which the low temperature properties of fuels are controlled in specifications. This second effect has resulted largely from the non-availability of realistic testing procedures for fuel oil pumpability. It is illustrated by the gradual increase in the specification temperature for viscosity in successive British Admiralty fuel oil specifications.

Directions for ordering papers on p 174

Although a large number of fields in America and the Far East are very waxy in type, the production of these fields is normally consumed locally and so does not have any widespread impact on quality. In contrast, practically the entire crude production from the Middle East, which is of a relatively waxy type, is exported. The rising importance of the Middle East therefore has resulted in an increase in the amount of waxy fuel oils marketed in temperate climates where they may tend to gel at the normal winter ambient temperatures.

The main emphasis must be on pumpability as a property of the oil, although the overall handling of an oil in an installation is a function of the installation also. This of course has a parallel in terms of straightforward viscosity, as with a "wax-free" oil; viscosity is a pure physical property of the oil quite independent of any installation or equipment, but rate of flow involves installation characteristics.

(*Continued on page* 254)

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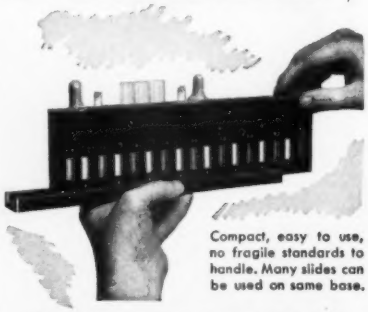

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More TECHNICAL BRIEFS

Begins on page 172

What we require is a physical property of the oil which will define its pumpability independently of the installation or measuring equipment, but a property we can apply, like viscosity, to any installation in order to derive the overall handling qualities. It is helpful to keep in mind the basic difference between cooling (a) a wax-free and (b) a waxy oil. The former increases in viscosity in a known and simple manner as the temperature falls; but it remains a true liquid (i.e. it will flow under a pressure difference, however small). The waxy oil behaves in the same way until some temperature is reached below which the "viscosity" increase is not according to a simple law: the viscosity has become anomalous, and at some lower temperature the oil may cease to behave as a true liquid because it is able to resist the application of a pressure difference. This state is indicated of course by the ordinary "pour point"; but for various reasons discussed, pour point cannot be regarded as any more than a probable indication of the pumpability of the oil. It is therefore necessary to choose some more suitable property of the oil, to define it, to lay down a method for measuring it which will be independent of the measuring apparatus, and to examine its correlation with large scale behavior. This the authors attempt to do. *API Paper, no number.*

More POWER NEWS

Begins on page 170

Circular concrete linings, 3-ft thick, will reduce the final diameter to 45 ft. These linings will require nearly a million cubic yards of concrete—more than enough to build a sidewalk from Boston to San Francisco.

Tunnel construction falls under two contracts: (1) B Perini & Sons, Inc, Walsh Construction Co and Canadian-American Contractors (2) Rayner-Atlas, Ltd. Blaw-Knox Co of Pittsburgh will supply the steel forms used for concrete setting.

On the average, one-fifth of the total flow of Niagara will pass through these tunnels. This amounts to 26-billion gallons of water daily—enough to meet the home needs of from ¼ to ½-billion people.

A U. S.-Canadian treaty, ratified Oct 10, 1950, makes water available for the power station. This treaty insures that at least 100,000-cfs of water must pass over the cataracts during the daytime hours of the mild-weather months. At all other times enough water must be

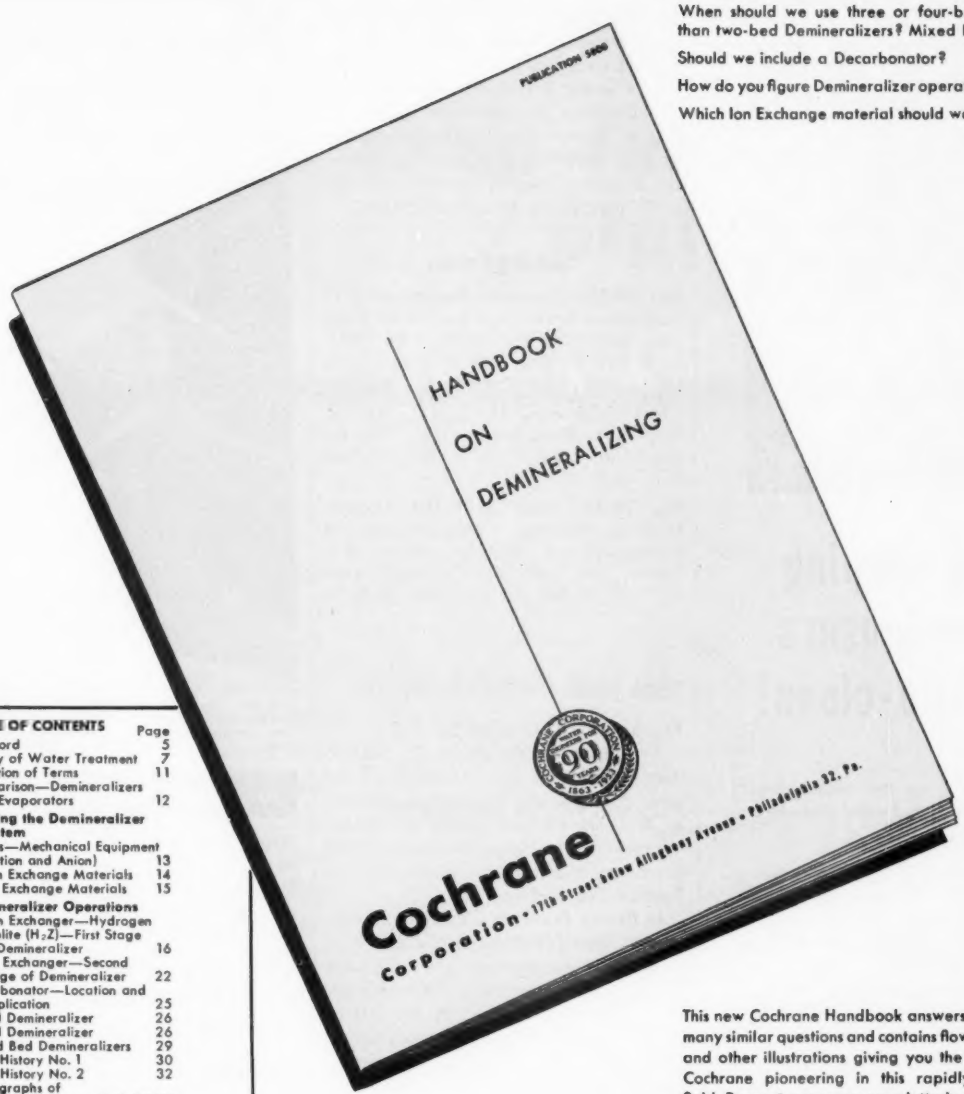
Why is Demineralization being selected instead of Evaporators?

When should we use three or four-bed rather than two-bed Demineralizers? Mixed Bed?

Should we include a Decarbonator?

How do you figure Demineralizer operating costs?

Which Ion Exchange material should we specify?



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This new Cochrane Handbook answers these and many similar questions and contains flow diagrams and other illustrations giving you the benefit of Cochrane pioneering in this rapidly growing field. Request a copy on your letterhead.

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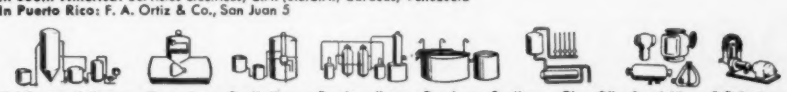

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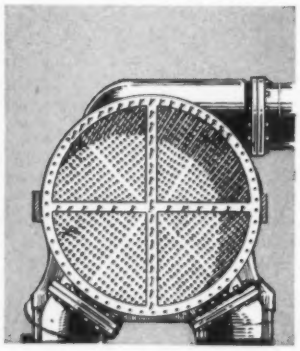

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More POWER NEWS

Begins on page 170

reversed to permit at least 50,000-cfs over the falls, weather permitting.

Another provision requires remedial works in the Upper Niagara Rapids to distribute the decreased flow more evenly over the crestlines of both cataracts. In this way, the agreement preserves the beauty of one of Nature's wonders while permitting its full utilization.

Coming Events

Oct 19-23—American Society of Civil Engineers, annual meeting, Statler Hotel, New York City. For details write ASCE, 33 W 39th St, New York 18, N. Y.

Nov 2-6—American Institute of Electrical Engineers, fall general meeting, Muelebach Hotel, Kansas City, Mo. For details write AIEE, 33 W 39th St, New York 18, N. Y.

Nov 18-20—Joint AIEE-IRE Conference on Electronic Instrumentation in Nucleonics and Medicine, Hotel New Yorker, New York City. For details write AIEE, 33 W 39th St, New York 18, N. Y.

Adolph Meyer *continued from page 170*

Franklin Hall, October 21, 1953.

Accompanying the award is a citation that reads: "In consideration of his basic contributions to scientific research on the Gas Turbine power plant and, in particular, to his pioneer work in the development of the first successful Gas Turbine Locomotive."

At Brown Boveri & Co, Baden, Switzerland, Dr Meyer developed the first continuous combustion Gas Turbine Locomotive for the Swiss Federal Railways. Placed in service in the fall of 1941, it is still in continous operation.

Dr Meyer has been the motivating spirit behind the gas turbine from its inception and by his encouragement and guidance of younger engineers working in the field, as well as by his own efforts, is primarily responsible for its present high level of development.

Born in Switzerland in 1880, Dr Meyer was graduated from the Swiss Federal Institute of Technology in 1903. He received doctors degrees from Stevens Institute of Technology, 1935, and from the Swiss Federal Institute of Technology in 1941. He was the Calvin Rice Lecturer in 1935 and twice received the George Stephenson Research Prize from the Institution of Mechanical Engineers. In 1950 he was elected a foreign honorary member of the American Academy of Arts and Sciences.

He is the author of many technical papers delivered both here and abroad. From 1923 to 1946 Dr Meyer was Man-

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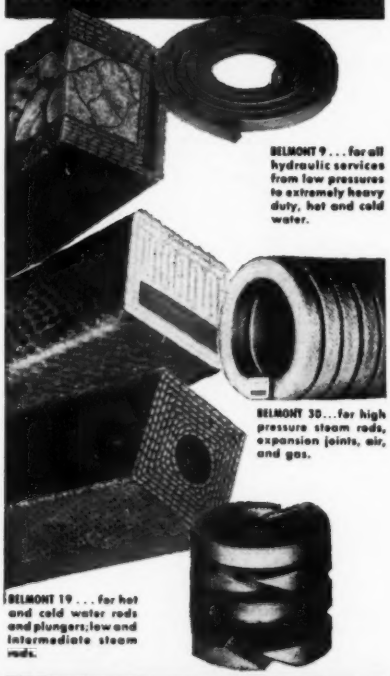
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is shop-fabricated piping that
saves manpower

The installation of Midwest Piping requires the minimum number of man hours because the difficult operations have been performed in the fabricating plants so that field erection time is reduced to a minimum. This makes possible earlier operation of the plant. Another reason for this time saving is that every subassembly is carefully checked before shipment to make sure it is dimensionally correct and accurate in alignment. The difficulty often encountered in securing skilled mechanics for field work makes this advantage of Midwest Shop-Fabricated Piping now more important than ever before.

From A Simple Bend

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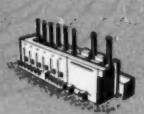
To Complete Piping Systems For Power Plant 

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The new Rotojet Junior Tube Cleaner has unusual power to clean small tubes quickly. This convenient, compact, self-contained cleaner, designed for one-man operation, needs very little headroom. Tube bundles can be cleaned without removal from shell.

Roto expanding heads and brushes with replaceable wearing elements save money and assure thorough cleaning of straight and curved tubes.

Send for Bulletin J-410 for full details.

S328 ROTOJET Junior Water-driven Motor, flexible coupling, and expanding scraper

C434 ROTOJET Junior Air-driven Motor, flexible coupling, expanding brush.

S32 ROTOJET Junior Air-driven Motor, cone cutter, universal joint.

ELLIOTT COMPANY-ROTO DIVISION

153 Sussex Avenue **Newark 1, N. J.**

More POWER NEWS

Begins on page 170

aging Director and Chief-engineer of Brown-Boveri & Co, Ltd. Since his retirement in 1946, he has served that firm in an advisory capacity and as director of the board.

Electronic 'Brain' Runs Automatic Elevators

► AN ELECTRONIC "BRAIN" that makes elevator service completely automatic was demonstrated recently in New York. The electronic traffic analyzer and automatic program selector are similar to control equipment now being installed by Otis Elevator Co in new and modernized buildings.

Since the new *Autotronic* elevators permit savings up to $7000 or more per elevator per year, building owners and managers are showing increased interest in the new system. Otis is now installing its system, complete with automatic program selection, in the 17-story Railway Exchange Building in Chicago and has similar contracts for other new and modernized buildings. Actually, over 80% of 1953 sales are for operatorless elevators.

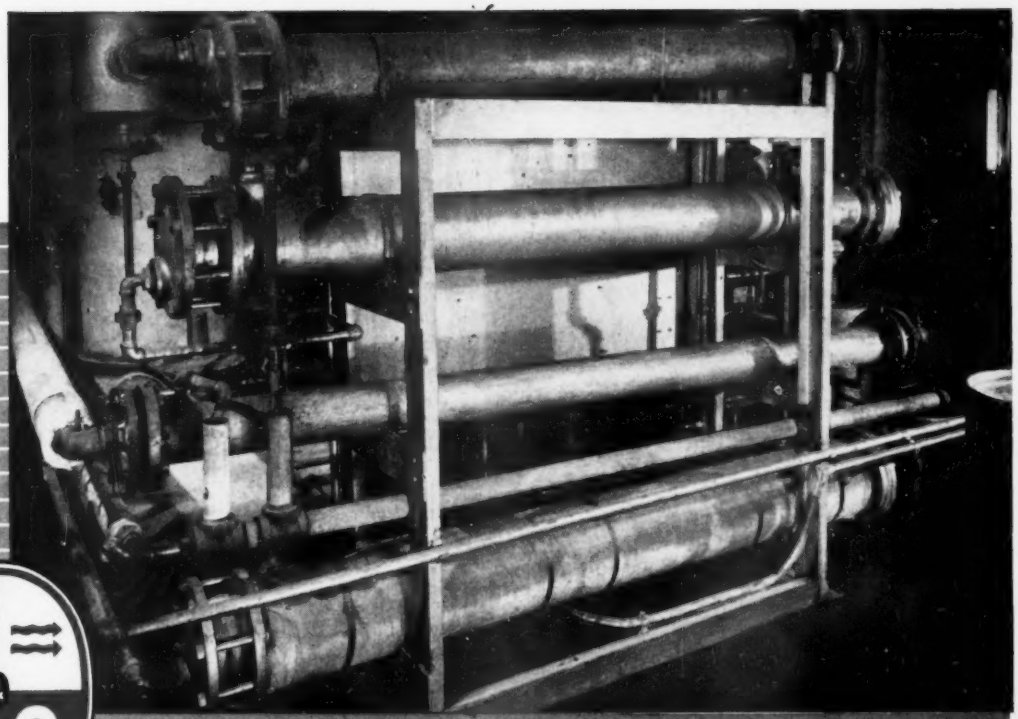
As first offered by Otis in 1948, *Autotronic* group supervision dispatched a bank of elevators according to a program selected by the starter. Six programs were available: Up-peak, Down-peak, Balanced up-down, Heavier down, Heavier up, and Intermittent. An electronic analyzer and automatic switch-over device went into action during heaviest part of down-peak and put the elevator on "Zone Return" to prevent poor service to lower floors.

Now, with automatic program selection, the traffic analyzer continuously records passenger calls and waiting time data. The selector then puts into effect the appropriate dispatching program and interval. When the traffic pattern changes, the control system promptly adjusts elevator service accordingly. Under the new system, *Autotronically* operated elevators handle all traffic conditions without any human intervention whatsoever. From the owner's standpoint, automatic program selection is an investment in improved elevator service.

New Zealand Taps Underground Steam for New Power Source

GOVERNMENT ENGINEERS of New Zealand are now using oil well drilling equipment in an attempt to tap veins of live steam in underground zones of thermal activity known to exist on North Island. Pools of boiling mud, geysers and other surface disturbances have

Battery of B&G Gas and Liquid Coolers

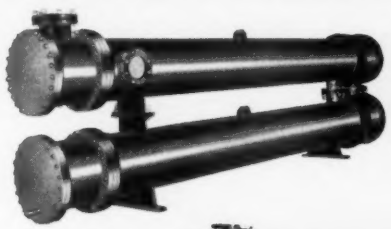


Hydro-Flo HEAT EXCHANGERS

Standard Design or built to your specifications

B & G *Hydro-Flo* Heat Exchangers are made in so wide a capacity and utility range that many requirements can be satisfied with standard units. If, however, special designs or materials are necessary, B & G equipment can be built to your specifications. The B & G engineering staff is always ready to assist in every way possible.

Whether standard or special, you'll find that B & G Heat Exchangers will meet your most critical appraisal. Sound design, backed by painstaking workmanship and rigid inspection assure equipment of top efficiency and long life. *B & G Hydro-Flo Products deliver more value per dollar because they are built that way!*



Two single pass, channel head B & G Heat Exchangers for series operation.

High pressure B & G Molasses Heater with fixed tube sheets and expansion joint design.

B&G Hydro-Flo shell-and-tube heat exchangers are available in the following types:

Straight and "U" Bend Tube Heat Exchangers • Fuel Oil Preheaters • Tank Suction Heaters • Aftercoolers • Gas Coolers • Water Heaters • Refrigeration Condensers and Evaporators.

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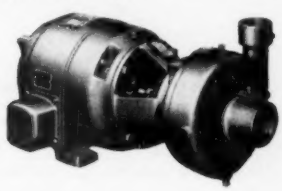
B & G CENTRIFUGAL PUMPS

Complete line for application in process industries and refrigeration and air conditioning installations. Send for catalogs.



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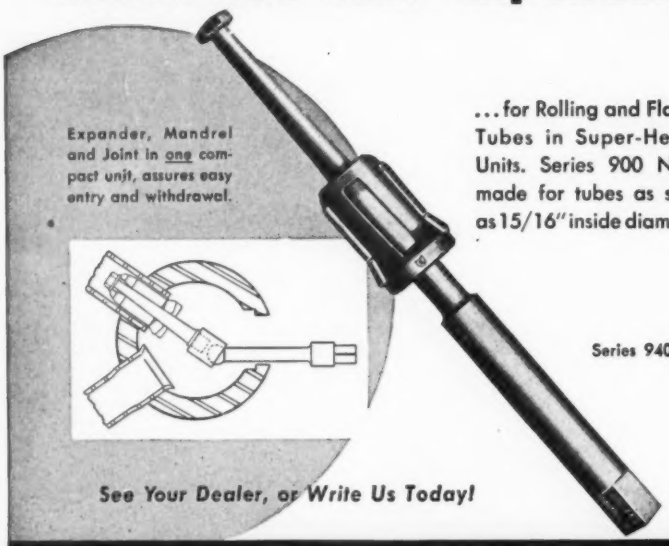
Series 900 Tube Expanders



Expander, Mandrel and Joint in one compact unit, assures easy entry and withdrawal.

...for Rolling and Flaring Tubes in Super-Heater Units. Series 900 NOW made for tubes as small as 15/16" inside diameter.

Series 940

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HENSZEY *Boiler Feed* REGULATOR

Keeps a **WATCHFUL EYE** *on* **BOILER WATER LEVELS**

• **CONTINUOUSLY** • **AUTOMATICALLY** • **ACCURATELY**
***under* ALL LOAD CONDITIONS**

They help avoid the hazards of high, as well as low, water levels. They function night and day—once installed and set for operation no attention is necessary — nothing to get out of order — nothing to rust.

A simple, compact unit — installs right in the line — no additional supports are necessary. Pressures up to 600 lbs., sizes up to 4 in.

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Continuous Blowdown • Distillation Systems • Heat Exchangers
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More POWER NEWS

Begins on page 170

long indicated the presence of underground thermal activity.

Early exploratory bores, deeper than 300 ft, have delivered up to 8000 lb of 94% dry steam per hour. The new plan is to bore to a depth of 5000 ft if necessary, despite high pressures that may be encountered. Engineers believe that temperatures near the boiling point will occur at 100 to 200-ft depths. They expect to encounter steam pressures of over 200 psi and temperatures of over 400 F as drilling progresses.

The immediate plan is to bring the steam to the surface in quantities sufficient to operate turbo-generators for the production of electrical power. But the ace-in-the-hole that may bring new prosperity to the British Commonwealth is the possibility that the steam may also be useful in the production of heavy water for use as moderator or coolant-moderator in atomic reactors. If estimates of the quantity that can be produced prove accurate and the venture is successful, New Zealand should have a supply of heavy water sufficient to facilitate the ultimate use of low-cost atomic energy.

Westinghouse Previews All-Aluminum Control Center

FIFTY-FIVE REPRESENTATIVES of Pittsburgh industry recently attended a preview of the first all-aluminum control center—65% lighter than its steel and copper counterpart.

Westinghouse Electric Corp developed this new center in response to requests from various industries, especially those in which cleanliness is paramount, such as food-producing, and those in which corrosive atmospheres are a problem, such as the chemical industries.

Built by the company's manufacturing and repair plant at Los Angeles, this aluminum control center was brought to Pittsburgh for examination by representatives from widely varied industries.

In addition to the good characteristics gained through the use of aluminum, the design of the center incorporates features that have made conventional units so popular: economical use of space, economy of installation, reduction of work hazards and efficient control supervision.

Power Behind the Curtain . . .

RUSSIA has announced large increases in power equipment output during the first six months of 1953, as compared with the same period last year. *Izvestia*, official government newspaper, reported production hikes of 30% in steam turbines, 40% in hydraulic turbines, 50% in boilers, and 60% in electric generators.

NEW

You need it! Send for free copy today!

United States Rubber Company, the only electrical wire and cable producer to grow its own natural rubber and to manufacture its own plastics and synthetic rubber, makes a complete line of electrical wires and cables for every industrial and domestic application. Just published is the 1953 "U.S." Catalog, essential for men who specify, install or maintain electrical wire and cable. Send for your free copy to address below. Here are the catalog chapter headings:

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2. U.S. Railroad Wires and Cables
3. U.S. Power Cables
4. U.S. Control and Signal Cables
5. U.S. Building Wires and Cables
6. U.S. Bare and Weatherproof Wires
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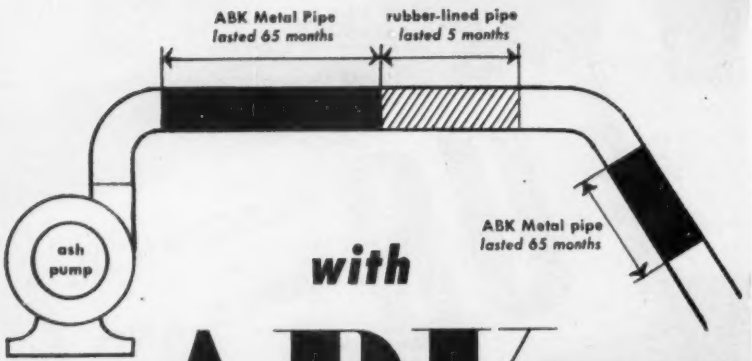
MORE than 10 TIMES the LIFE

in this ash system test



with

ABK METAL

THIS ash removal system was installed five years ago in a Midwestern power station. More than 100 feet of ABK Metal pipe and rubber-lined pipe were specified for the purpose of a comparison test. Results serve as one more illustration that ABK Metal outlasts other types of abrasion-resistant materials. For ABK Metal gave *thirteen times* the life of special rubber-lined pipe.

So the evidence keeps rolling in that ABK Metal is the most economical material for handling abrasive ash. Savings on replacement parts plus reduction in down time and maintenance add up to really worthwhile operational economies. ABK Metal minimizes the destructive wear of abrasive ash and clinker because of the controlled, uniform structure and extreme hardness of this nickel-chrome iron.

Don't let wet or dry ash abrasion steal your operating dollars. Specify castings in ABK Metal, an exclusive Brake Shoe product.

QUALITY CASTINGS IN ABK METAL.. MEEHANITE... DUCTALLOY

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1744

AMERICAN Brake Shoe COMPANY

BRAKE SHOE AND CASTINGS DIVISION
230 Park Avenue, New York 17, N. Y.

More POWER NEWS

Begins on page 170

bines, 11% in large hydroturbines, 62% in turbogenerators and 86% in hydrogenerators.

Some Pro's and Con's On Atomic Energy

► THE U. S. ARMY has started preliminary studies concerning the feasibility of using nuclear reactors to supply electric power for remote military bases. Objective of these studies is to estimate costs of such power and assess them, both costwise and in the light of possible emergencies, against orthodox power operations at certain army installations.

Bases now being considered and other details of this study are under heavy secret wraps. But the defense department has been buzzing with speculation over the feasibiilty of atomic power plants at outposts such as the fuel-short Thule Air Base on Greenland. There has been some talk, too, about power reactors at island bases whose supply lines might be cut in event of war.

Only one power reactor of capacity and design pertinent to the army study is now in existence. This is the land-based prototype of a submarine propulsion unit now undergoing tests at the AEC Proving Grounds near Arco, Idaho. Built by Westinghouse Electric Corp and AEC's Argonne National Laboratory, this unit has a reported useful capacity in excess of 12,000 kw.

Some authorities estimate that a similar reactor can be built now to produce power at costs ranging from three to six cents per kwh.

ATOMIC ENERGY IN INDUSTRY will be the subject of the 2nd Annual Conference of the National Industrial Conference Board, Inc. A special meeting of the board, this conference will be held October 29-30 in the Waldorf-Astoria Hotel, New York.

The following subjects will be covered in the various discussions: *(1) Changing the Atomic Energy Act—Pro and Con (2) Reactor Design and Technical Developments in New Metals and Coolants (3) Developing Commercial Atomic Power—Analysis of Company-Group Feasibility Studies (4) Cutting Costs Through Use of Radioisotopes (5) Possible Economic Impact of Atomic Energy (6) Improving Product Quality with Use of Radioisotopes.*

Throughout the 2-day conference, the following reactor models will be on display on the Sert Room Terrace:

(1) Brookhaven Reactor — a scale model of one of the worlds largest reactors used solely for research. This

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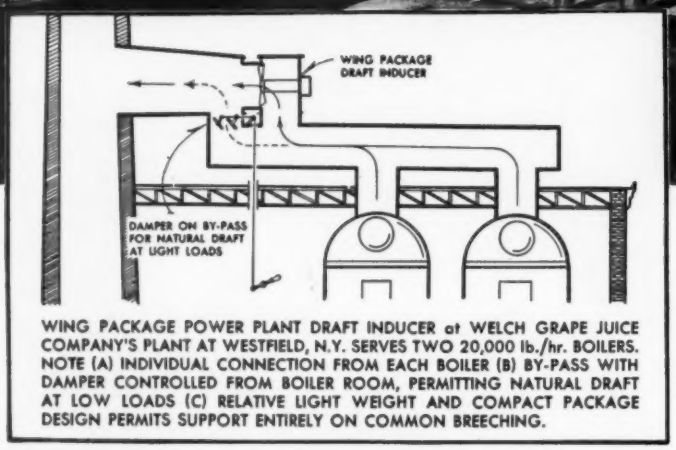
The WING Package DRAFT INDUCER



WING PACKAGE POWER PLANT DRAFT INDUCER at WELCH GRAPE JUICE COMPANY'S PLANT AT WESTFIELD, N.Y. SERVES TWO 20,000 lb./hr. BOILERS. NOTE (A) INDIVIDUAL CONNECTION FROM EACH BOILER (B) BY-PASS WITH DAMPER CONTROLLED FROM BOILER ROOM, PERMITTING NATURAL DRAFT AT LOW LOADS (C) RELATIVE LIGHT WEIGHT AND COMPACT PACKAGE DESIGN PERMITS SUPPORT ENTIRELY ON COMMON BREECHING.

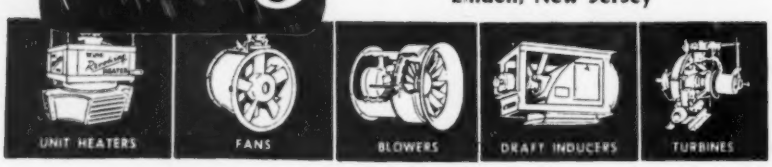
The WING Package DRAFT INDUCER is unique in that the motor (or turbine) and fan is designed as one complete removable unit, making installation easier and being easily removed, facilitates inspection and maintenance. Other advantages are:

1. Big savings in space requirements
2. Permits fewer and lighter structural supports
3. Eliminates field line-up problems
4. Eliminates water cooling
5. Only two support bearings
6. Wide flexibility in gas outlets
7. Saves on investment and maintenance
8. Low load ratings on natural draft because of ample free gas travel area

Write for complete details

L. J. Wing Mfg. Co.
50 Vreeland Mills Road
Linden, New Jersey

Wing



More POWER NEWS

Begins on page 170

plant is operated by Associated Universities, Inc under contract with the AEC.

(2) Atomic Submarine Reactor—a ⅛ in. model of the plant being built by General Electric Co to power the first atomically driven submarine.

(3) Commercial Atomic Power Plant —a model of the reactor designed and built by North American Aviation, Inc to deliver 10,000 kw.

On the Wednesday preceding the conference, Brookhaven National Laboratories will give 100 of those attending a 4-hour conducted tour of their atomic installations. Since attendance is limited, reservations will be honored in order of receipt.

LIQUID SODIUM is undergoing handling tests in an experimental installation at the Knolls Atomic Power Laboratory. General Electric Co, working for the Atomic Energy Commission, is studying the problem of electromagnetically pumping and metering the liquid metal used as a reactor coolant.

The company has devised a closed circuit loop to obtain performance curves by computing pressure versus flow, using voltage, pressure, and sodium temperature variants. Temperatures range from 580 to 1000 F; pressures, from 0 to 75 delta pressure. A magnetic flowmeter measures gallons per minute within an accuracy range of 2 percent.

The pump and flowmeter developed for installations such as this one operate on magnetic principles and have no moving parts. They are now commercially available from the G-E Special Products Section.

ELECTRIC MONITORS soon will control the operations of atomic piles, according to Minneapolis-Honeywell Regulator Co. The first "packaged" automatic control system includes amplifiers, servo-amplifiers, recorders, controllers and servo motors.

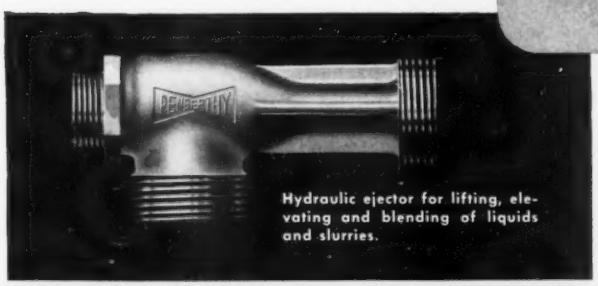
These will regulate the rate of power generation of the nuclear reactors at predetermined levels. The new system also provides robot-like safeguards against dangerous operating conditions and will be especially valuable when private industry starts converting nuclear energy into electric power.

ATOMIC ENERGY COMMISSION projects are using more than 1000 large electric motors ranging in size from 350 to 950 hp. Westinghouse Electric Corp's Pittsburgh and Buffalo plants will supply the entire order. The larger motors will have an efficiency rating exceeding 96% and will be designed to run continuously for 365 days a year. All units will have electrically operated brakes.

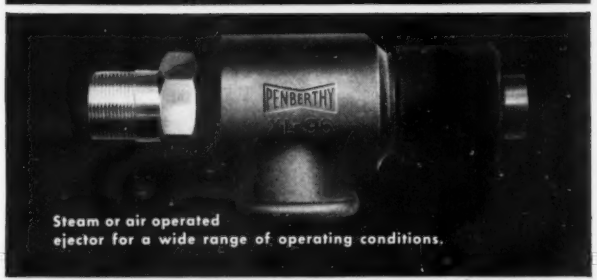
ATOMIC UTILITIES OF ARIZONA has applied to the Arizona Corporation Commission for a statewide certificate to construct and

LOW COST...
COMPACT...
TROUBLE-FREE...

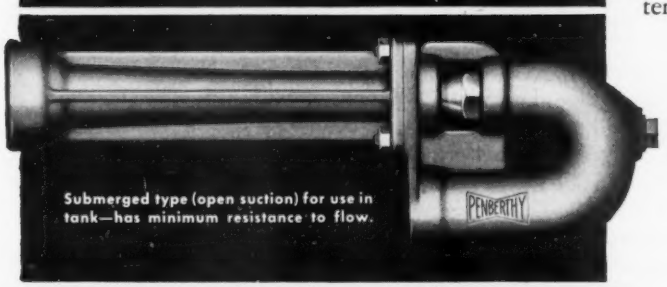
PENBERTHY
JET PUMPS



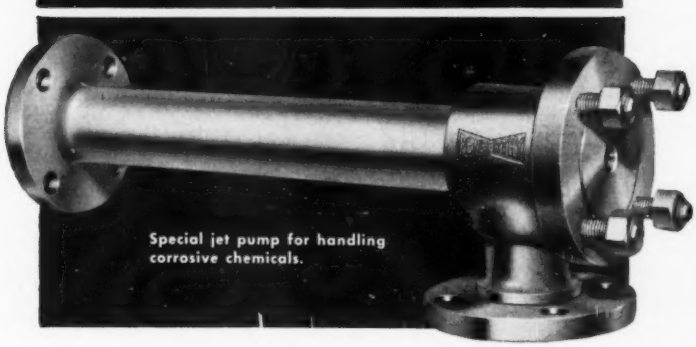
Hydraulic ejector for lifting, elevating and blending of liquids and slurries.



Steam or air operated ejector for a wide range of operating conditions.



Submerged type (open suction) for use in tank—has minimum resistance to flow.



Special jet pump for handling corrosive chemicals.

Consider the simplicity of the jet pump. It uses steam, water, air or gas under pressure to transfer or mix, without clogging, *any liquid which will flow through pipes.* It has no moving parts or packing glands. Needs no lubrication or maintenance. It's practically noiseless, costs little and is compact.

Penberthy makes a full range of jet pumps. They are being used in standard and unusual applications. Where necessary, they are made to withstand corrosion, contamination and high temperatures.

Penberthy, from wide experience, can help you save time and money, increase the efficiency of your operation. Take the first step by writing for Bulletin No. 512 which details the complete line of jet pumps by Penberthy.

★

Established 1866

PENBERTHY INJECTOR COMPANY

Division of the Buffalo-Eclipse Corporation

1255 Holden Avenue
Detroit 2, Michigan

There's Certain satisfaction in **PRODUCTS BY**

PENBERTHY

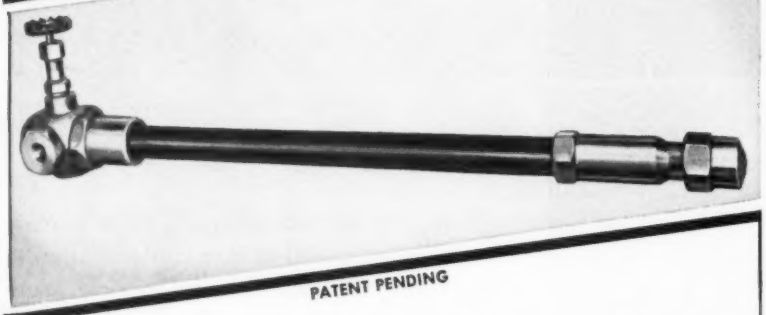
- **CYCLING JET PUMPS**
- **EJECTORS**
- **INJECTORS**
- **ELECTRIC SUMP PUMPS**
- **EDUCTORS**
- **EXHAUSTERS**
- **SYPHONS**

NATIONAL AIROIL

OIL BURNERS

of the steam and mechanical types now combined into

DUAL STAGE BURNERS



PATENT PENDING

Now, at last, the inherent advantages of *both* systems of fuel oil atomization are *profitably* yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

41 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H.R.T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

Get detailed description, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

- OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
- STEAM ATOMIZING OIL BURNERS
- MOTOR-DRIVEN ROTARY OIL BURNERS
- MECHANICAL PRESSURE ATOMIZING OIL BURNERS
- AIR INTAKE DOORS
- OBSERVATION PORTS
- SPECIAL REFRACTORY SHAPES
- LOW AIR PRESSURE OIL BURNERS
- AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
- GAS BURNERS
- COMBINATION GAS & OIL BURNERS
- FUEL OIL HEATERS
- FUEL OIL PUMPING and HEATING UNITS
- FURNACE RELIEF DOORS

NATIONAL AIROIL BURNER CO., INC.

1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.
Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

More POWER NEWS

Begins on page 170

operate service equipment and facilities for producing and distributing atomatically-generated energy. This is the first such filing in the state and may be the first in the country.

The company is also exploring possibilities of obtaining a franchise to build and install an atomic plant developed by North American Aviation Corp (See August Power, p 148). At present the corporation is financed to conduct advanced research; additional financing is necessary to undertake an atomic energy plant.

NUCLEAR POWER has become a separate division at Combustion Engrg, Inc. The company is currently pursuing several projects for the development of equipment for nuclear power generation. Among these are the supplying of major components for an atomic-powered submarine, problems of design and metallurgy involved in using the heat generated in nuclear reactors.

NEW MOTION PICTURE entitled *A Is For Atom* has been reviewed and endorsed by the Atomic Energy Commission. The color film explains the phenomenon of nuclear fission and highlights its potential benefits in medicine, industry, agriculture, etc. Industrial firms interested in using the film for employee or public showings may obtain it on loan from film libraries of General Electric Co district offices, or may purchase a copy at print cost of $80.

Power Across the Nation . . .

CALIFORNIA-OREGON POWER CO has ordered two automatic hydroelectric package power plants from Westinghouse Electric Corp for the Lemola No 1 and No 2 stations. These plants, consisting of waterwheel generators, transformers and switchgear, will add 2,000-kw electrical capacity to the utility's system.

DETROIT EDISON CO has test run the first steam turbine generator installed in its new St Clair Power Plant. The new unit is one of four to be installed; each machine has a capability of 200,000 hp. After completion, total plant generating capability will be more than 3,300,000 hp.

BUREAU OF RECLAMATION'S $28.8-million multi-purpose Canyon Dam project nears completion with the first of three 16,667-kw generators in its power house scheduled to go on the line this fall. Located on the Missouri east of Helena, Mont., the dam will have a 2,051,000 acre-ft capacity. The spillway, controlled by largest radial type gates ever installed on a Bureau project, has a capacity of 150,000 cfs.

PUBLIC SERVICE CO of Denver is installing an additional 66,000-kw steam turbine-generator at its Zuni plant. Total cost of expansion is $11,675,000.

NEWS ABOUT "TEFLON"

How valve components of Du Pont "Teflon"* are giving improved performance at less cost

Du Pont "Teflon" tetrafluoroethylene resin has found increasing use as a material for valve components—gaskets, packings, seats and discs, plug valve parts and diaphragms. It provides a unique combination of properties of particular interest to manufacturers and users of valves.

- **CHEMICAL INERTNESS.** "Teflon" is completely unaffected by acids, alkalis, aliphatics, aromatics, chlorinated hydrocarbons . . . *all* chemicals except molten alkali metals and fluorine at elevated temperatures.
- **HEAT RESISTANCE.** Gives continuous service up to 500°F.
- **LOW-TEMPERATURE TOUGHNESS.** Has been used as low as –460°F.
- **LOW COEFFICIENT OF FRICTION.** Lets the valve operate easily. Requires no lubrication.
- **EROSION RESISTANCE.** Resists erosion by impinging fluids.

Valves with components of Du Pont "Teflon" are especially useful to manufacturers of: chemicals, fertilizers, petroleum, soap, chlorine, foods, plastics, sugar, dyes, insecticides, rubber, textiles, explosives, paper, pharmaceuticals, photographic film.

The Polychemicals Department of the Du Pont Company supplies "Teflon" in the forms of molding powders and aqueous dispersions. These forms are converted into various valve components and molded articles by a number of manufacturers for use in chemical and allied equipment. For further information, write: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 2610, Du Pont Bldg., Wilmington 98, Delaware.

*REG. U.S. PAT. OFF.

DU PONT
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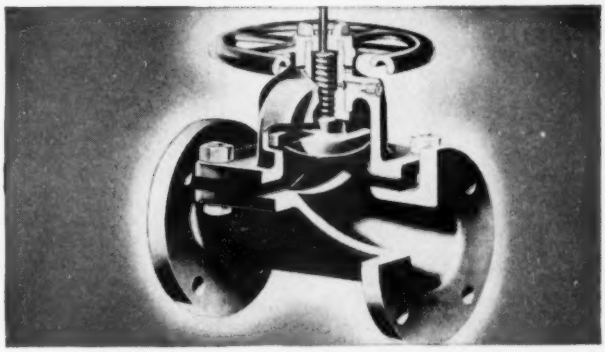
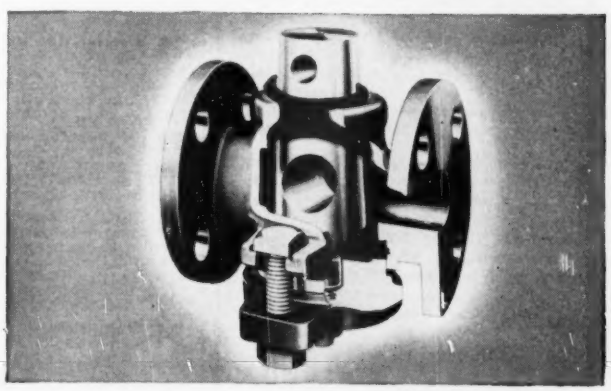
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS



VALVE DIAPHRAGMS demonstrate the chemical inertness and thermal stability of Du Pont "Teflon." This diaphragm of pure "Teflon," above, was designed for continuous operating pressures of 100 psi and temperatures of 400°F. The valve is made by Hills-McCanna Co., Chicago.

GASKETS AND PACKINGS of "Teflon" often outlast the valve itself. Available in many forms for varied valve uses. Du Pont "Teflon" resists corrosive attack, insures a tight seal. Pictured is a chemical porcelain valve made by the Lapp Insulator Co., Inc., LeRoy, N. Y.



PLUG VALVE COMPONENTS (sleeves and cock washers) utilize the low coefficient of friction and non-adhesive characteristics of "Teflon." They prevent sticking or freezing in the valve body, often simplify design, give excellent results. The valve above is made by The Duriron Co., Inc., Dayton, O.

No Other Valve Like

LONERGAN
UNI-LINE
41-W-200 SERIES

Here's why . . .

- *a Much Higher capacity* per size, than any other safety valve.
- *a free-acting, self-aligning disc.*
- a *"floating" guide* (readily adjustable for control) . . . assists in opening and closing action, as well as affording an additional self-aligning feature.
- a Disc and Disc holder of *forged copper alloy*, not castings.

Briefly, these "features" offer the following advantages:

Reduction in size of boiler opening required to mount valve, due to *larger capacity* from smaller valve sizes—and thus reduced cost of discharge piping. Reduction in boiler headroom. Reduction in shipping charges (less weight). Easier and more positive operations. Easy replacement or re-conditioning of working parts (low maintenance).

Available in sizes from 1½" through 6", Lonergan UNI-LINE Valves are V & W National Board approved design . . . product engineered for economy. (A leading boiler manufacturer, name available, has tested, approved and highly appraised all claims.)

Write for new descriptive literature.

Lonergan

J. E. LONERGAN CO.
ESTABLISHED 1872
2nd & Race Sts., Phila. 6, Pa.

More FREE BULLETINS

Begins on page 185

13 **Graphic control** panels discussed in 4-page, 2-color leaflet. Photos show typical applications and various techniques of graphic symbolism. Bulletin P1-153. Panellit, Inc, 6312 N Broadway, Chicago 40, Ill.

14 **Unit regulators** for flow, pressure, proportioning and other variables covered in 8-page, 2-color booklet. Application diagrams, photos, specs included. Bulletin #155, Askania Regulator Co, 240 E Ontario St, Chicago 11, Ill.

15 **Pneumatic controller** described in 4-page, 2-color catalog. Working sketches, photos, diagrams of installations and specs included. Catalog #53-11, Fischer & Porter Co, Hatboro, Pa.

ELECTRICAL EQUIPMENT

16 **Insulated aluminum** power cables and self-supporting aerial cables with aluminum conductors presented in two booklets. Each includes photos and complete specs for various types of equipment. Bulletins OK-1064 and OK-1070, Okonite Co, Passaic, N. J.

17 **Totally enclosed** dry-type transformers for indoor or outdoor 3 to 50-kva service discussed in 8-page, 2-color booklet. Photos and cutaways show installation. Bulletin B-5812. Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

★ **Pocket-size** wiring data and weight computer supplies complete information for insulated wire and cable for all electrical purposes. ★Request direct on company letterhead to J Q Bourne, Dept 19, Hatfield Wire & Cable, Hillside, N. J.

18 **Combination** motor starters cover range of sizes from 0 to 5, 6 to 400 hp, 600 v ac and can be obtained with local, remote or selector switch control. Photos and full specs listed. Bulletin #514-515. Federal Electric Products Co, 1429 Park St, Hartford 6, Conn.

★ **Standard and special** carbon and graphite components and materials for chemical, electrical and mechanical applications described in 44-page catalog 40A. Engrg data on properties of carbon and graphite as compared with metals and other refractory materials. ★Request direct on company letterhead to Stackpole Carbon Co, St Marys, Pa.

19 **New and rebuilt** motors, generators and allied equipment presented in 6-page newsletter called *Wagner Motor-Gram*. Arthur Wagner Co, 1436 W Randolph St, Chicago 7, Ill.

HEAT EXCHANGERS

20 **Oil burning** systems presented in 4-page, 2-color bulletin. "Before" and "After" pictures of several installations included. Peabody Engrg Corp, 580 5th Ave, New York 36, N. Y.

21 **Combustion safeguards** for multiple oil or gas burners featured in 4-page folder. Photos, schematic diagrams, general specs included. Bulletin 9603-1, Minneapolis-Honeywell Regulator Co, Philadelphia 44, Pa.

22 **Oil burning units** for heating blast stoves in iron and steel plants where gas is not available listed in Catalog Sheet #457. Hauck Mfg Co, 124-136 10th St, Brooklyn 15, N. Y.

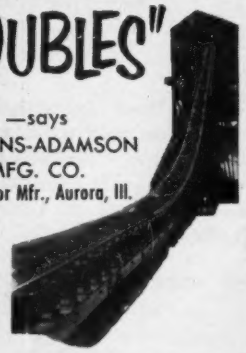
23 **Unit heaters** for commercial, industrial, institutional systems covered in 12-page, 2-color booklet. Photos graphically illustrate solutions to many heating problems. Bulletin 14, Industrial Unit Heater Assn, 2159 Guardian Bldg, Detroit 26, Mich.

24 **Belt-driven,** horizontal rotary-type, heavy-oil burners described in 8-page, 2-color booklet. Photos, sketches, phantom views and full specs show design and application features. Bulletin 175-G, Preferred Utilities Mfg Corp, 1860 Broadway, New York 23, N. Y.

25 **Methods and means** of various types of industrial water heating system applications discussed in 14-page booklet. Pick Mfg Co, West Bend, Wis.

"NO MORE LUBRICATION TROUBLES"

—says
STEPHENS-ADAMSON
MFG. CO.
Conveyor Mfr., Aurora, Ill.

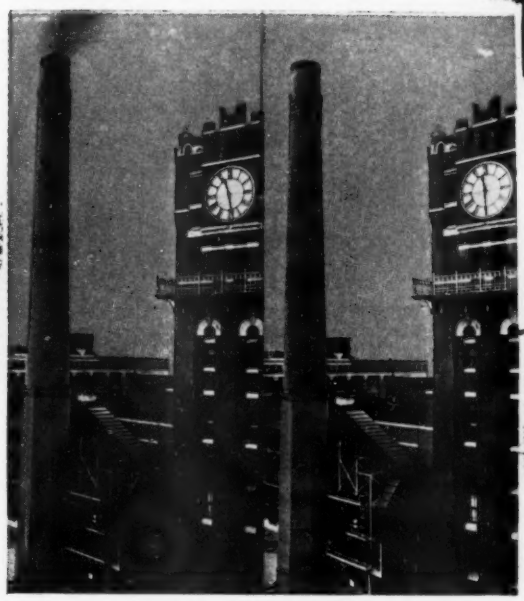


"LUBRIPLATE Lubricants satisfy the 'one-shot' requirements of our conveyor idlers. LUBRIPLATE effectively lubricates each bearing in turn and flows through the hollow shaft to the next bearing. We do not know of a single case of bearing trouble through faulty lubrication where LUBRIPLATE has been used."

For nearest LUBRIPLATE distributor, see Classified Telephone Directory. Send for free 56-page "LUBRIPLATE DATA BOOK"... a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.

Less dust for St. Louis housewives...



Boiler No. 5 Stack and Precipitator left—before precipitator start-up right—precipitator in operation [boiler load 200,000#/hr.]

Anheuser-Busch leads the way

with AEROTEC Electrical Precipitators

The brewers of famous Budweiser Beer know the importance and value of good public relations. Not content with just meeting local requirements for dust control, the Company sets the pace for air-pollution control in St. Louis.

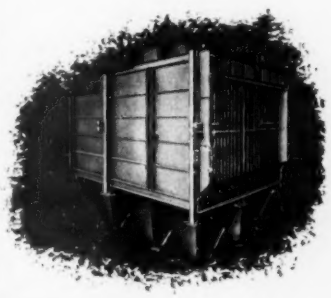
Together with an existing mechanical collector, the first of five Aerotec Electrical Precipitators at Anheuser-Busch *is collecting 2000 lbs. of dust every 60 minutes from a single stack.*

The remaining four electrical precipitators are about to be placed in service, and dust emission will be less than one fourth of the maximum allowable under the requirements of St. Louis' dust ordinance.

Reasons for Aerotec's higher collecting efficiency are:

- Pocket-type collecting electrodes prevent precipitated dust from re-entering gas stream.
- Exclusive flat high voltage plate presents a field of uniform maximum intensity for most effective precipitation.

For other advantages of Aerotec Electrical Precipitators write or call our project engineers—Thermix Corporation.



Project Engineers **THE THERMIX CORPORATION** Greenwich, Conn.

(Offices in 38 Principal Cities)

Canadian Affiliates: T. C. CHOWN, Ltd., Montreal 25, Quebec; Toronto 5, Ontario

Manufacturers

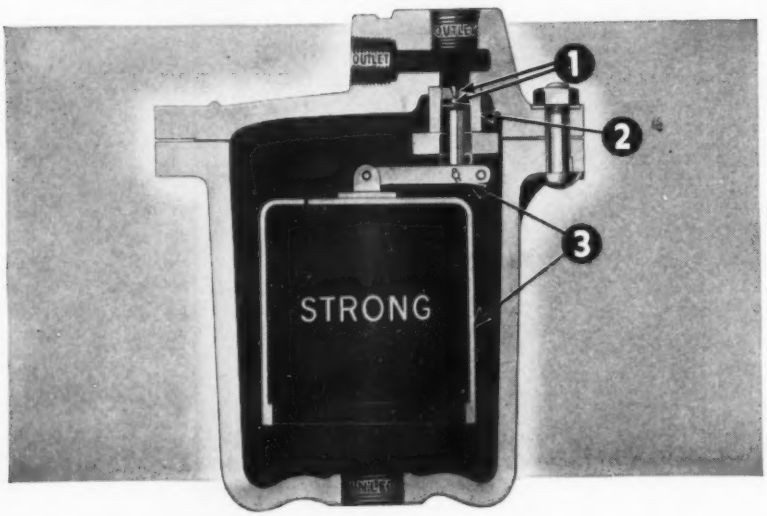
THE AEROTEC CORPORATION

GREENWICH, CONN.

3 Reasons

STRONG* Traps

are easy to maintain!



Look for these three STRONG low-maintenance features in the STRONG 80 Series Inverted Bucket Trap:

1. **Anum-Metl Valve and Seat—guaranteed leakproof for one year;**
2. **Bolted-in seat design—insures tight seal, easy servicing;**
3. **Stainless steel bucket and trim.**

Compare these features with other traps!

STRONG 80 Series Trap sizes ½" to 2½", pressures to 250 lbs., temperature to 500° F. (forged steel for higher pressures).

Dual outlet simplifies piping, bottom inlet keeps trap cleaner. Years of trouble-free operation assured by super-STRONG construction.

Catalog No. 68-H describes inverted, open bucket and other types of STRONG traps. Write today.

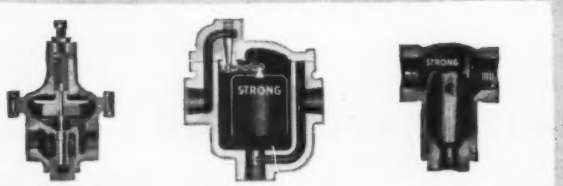
*Trade Mark Reg. U. S. Pat. Off.

STRONG, CARLISLE & HAMMOND COMPANY

1392 West 3rd Street
Cleveland 13, Ohio

ANUM-METL Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES



Reducing Valve | 70 Series Trap | Strainer

STRONG

More FREE BULLETINS

Begins on page 185

26 **Low air pressure** oil burners and airovent centrifugal blowers covered in 16-page 2-color booklet. Photos, dimensional drawings, full specs give complete picture of units and accessories. Bulletin 65, Nat'l Airoil Burner Co, Inc, 1284 E Sedgley Ave, Philadelphia 34, Pa.

27 **Oil and combination** gas-oil burners featured in 16-page, 2-color, fully illustrated catalog. Includes fully automatic, semi-automatic and manually controlled horizontal rotary and steam-turbine driven burners with specs and capacities. Ray Oil Burner Co, 1301 San Jose Ave, San Francisco 12, Calif.

INSULATION

★ **Reference manual** describes in detail 36 coatings and adhesive products for use in installation and surface protection of industrial insulations. Includes technical data, specifications, application procedure. ★Request direct on company letterhead to Benjamin Foster Co, 4639 W Girard Ave, Philadelphia 31, Pa.

28 **Fiber-glass yarns** for electrical insulation discussed in 4-page folder. Information on standard packaging, specs, data on thermal conductivity, heat and acid resistance, dielectric strength, etc. Libbey-Owens-Ford Glass Co, Toledo 3, Ohio.

29 **Blanket-form** insulation for combined heat and noise control in metal industrial structures presented in 4-page, 2-color folder. Complete standard data chart included. Libbey-Owens-Ford Glass Co, Toledo 3, Ohio.

30 **Pocket-size** folder entitled *Teammates* tells how to use *Scotchfil* insulation putty and *Scotch* plastic electrical tape. Includes physical and electrical properties of both materials. Minnesota Mining & Mfg Co, 900 Fauquier St, St Paul 6, Minn.

MAINTENANCE, SAFETY EQUIPMENT

31 **Dual - purpose** coupling repair clamp featured in 2-color, 6-page leaflet. Explains how device repairs gas, water and petroleum pipe lines. Folder 101, Morris Coupling & Clamp Co, Dept J-51, Ellwood City, Pa.

32 **Pipe tools** covered in 8-page, 2-color catalog. Includes photos, full specs, price list for tools such as threaders, cutters, reamers, sawing vises, etc. Beaver Pipe Tools, Inc, Warren, Ohio.

33 **Centralized** systems of lubrication discussed in 20-page, 3-color booklet. Includes valves, pumps, fittings and accessories. Photos, dimensional drawings, full specs. Bulletin 26, Farval Corp, 3295 E 80th St, Cleveland 4, Ohio.

34 **High strength** paste alloy solders presented in 4-page, 2-color folder. Details on electrical, electronic, mechanical bond paste solder and brazing alloys and new two-part soldering technique. Bulletin FF-1, Fusion Engrg, 4504 Superior Ave, Cleveland 3, Ohio.

35 **Portable fire** extinguishers for Class A, B, C fires outlined in 8-page brochure. Covers smoke and temperature-rate-of-rise detection systems as well as automatic carbon dioxide systems. Bulletin P8R5, Walter Kidde & Co, Inc, Main St, Belleville 9, N. J.

MATERIALS HANDLING

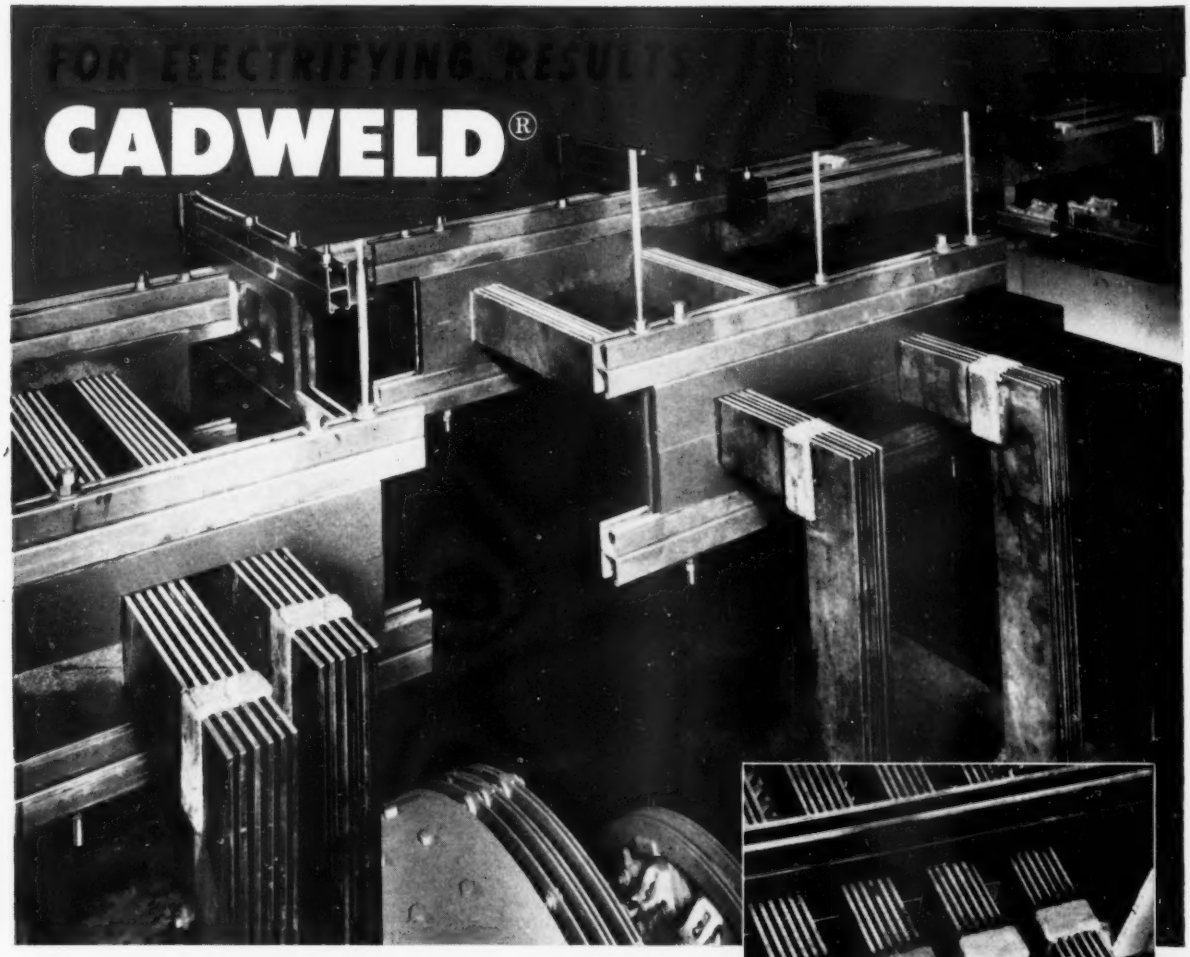
36 **Belt conveyor** idlers featured in 48-page, 2-color catalog. More than 500 types shown with photos, specs, and sectional-dimensional drawings. Book #2416, Link Belt Co, 307 N Michigan Ave, Chicago 1, Ill.

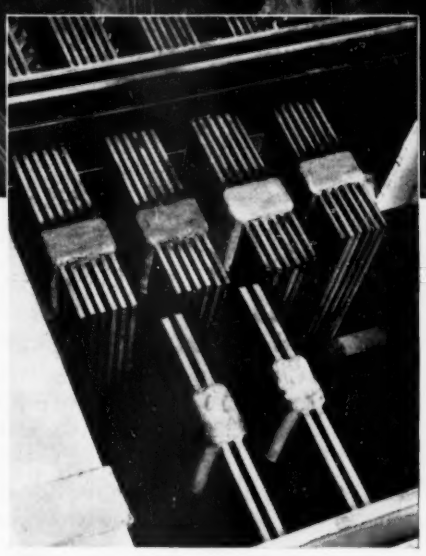
37 **Power shovels** and cranes, Lorain "80" Series, covered in 12-page, 2-color, fully illustrated bulletin. Machines are in 1¾-yd class on shovels. Thew Shovel Co, Lorain, Ohio.

38 **Hoists and cranes,** both air and electric units, presented in 4-page,

FOR ELECTRIFYING RESULTS

CADWELD®





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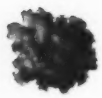

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More FREE BULLETINS

Begins on page 185

2-color folder. Photos and specs for various types. Bulletin 725B, Detroit Hoist and Machine Co, 8201 Morrow St, Detroit 11, Mich.

39 **Diesel** industrial tractors equipped with *Shoreloader* assemblies discussed in 4-page, 2-color folder. Photos and full specs. Bulletin A5201-1, Baker-Lull Corp, 314 W 90th St, Minneapolis 20, Minn.

MECHANICAL TRANSMISSION

40 **Roller chain** wheels with taper bushings covered in 16-page, 2-color booklet. Photos, dimensional drawings, full specs included. Book 2449. Link-Belt Co, 307 N Michigan Ave, Chicago 1, Ill.

41 **Packaged** adjustable-voltage drives for variable speed applications featured in 16-page, 2-color booklet. Full specs and photos on construction, application, operation. Booklet B-5808, Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

42 **Worm gearing** and its application and performance throughout industry explained in 36-page, 2-color booklet entitled, *Cone-Drive Gears at Work in Industry*. Presents 93 successful applications in 20 different industrial classifications. Bulletin CD-173, Michigan Tool Co, Cone-Drive Gears Div, 7171 E McNichols Rd, Detroit 12, Mich.

METAL & ALLOYS

43 **Copper** and its alloys discussed in 28-page, 2-color booklet entitled, *Corrosion Resistance of Copper and Copper Alloys*. Explains chemical and physical nature of corrosive attack in its various forms. Photos and property specs included. Bulletin B-36R, American Brass Co, 25 Broadway, New York 4, N. Y.

44 **Aluminum** and its uses in process industries treated in 8-page illustrated booklet. Spec tables show materials that may be handled with aluminum, composition and properties of alloys, other engrg data. Aluminum Co of America, 808 Alcoa Bldg, Pittsburgh 19, Pa.

45 **Iron ore** beneficiation with the application of electric power described in 20-page illustrated booklet. Types of electrical equipment and systems best suited for each phase included. Booklet B-5858, Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

46 **New types** of stainless alloy products with applications in oil, chemical, petro-chemical industries discussed in 10-page, illustrated booklet. Solar Aircraft Co, San Diego 12, Calif.

METERS & INSTRUMENTS

47 **Orifice meter** flow control unit for boiler blow-off covered in 8-page, 3-color, illustrated bulletin. Metering pumps for use with corrosive and abrasive fluids outlined in 8-page, 2-color, illustrated bulletin. Both booklets contain complete specifications. Madden Corp, 1543 Morse Ave, Chicago 26, Ill.

48 **Electrical,** mechanical and liquid level flow meters outlined in series of data sheets. Photos and specs included for each instrument. Spec sheets 241 through 246 incl. Minneapolis-Honeywell Regulator Co, Philadelphia 44, Pa.

49 **Fuel flow** instruments, controls, and accessory fittings presented in compilation of bulletins. Photos, full specs, performance data for various types of equipment listed. Bulletins 1100, 1200, 1300, 1400, 1600, and 1800. Revere Corp of America, Wallingford, Conn.

50 **Speed measurement** by vibration of tuned steel reeds as a substitute for mechanical tachometers and speed indicators described in 16-page, 2-color, illustrated booklet. Bulletin 31-P8, James G Biddle Co, 1316 Arch St, Philadelphia 7, Pa.

51 **Meters** for the measurement of liquids and gases by variable area

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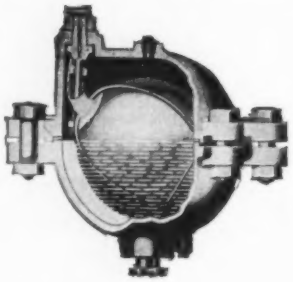

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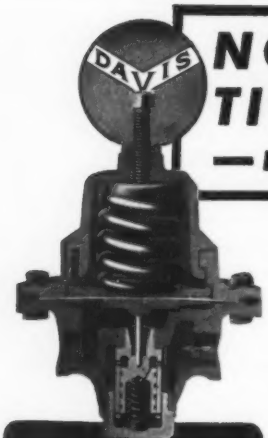

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More FREE BULLETINS

Begins on page 185

method covered in 16-page catalog 10-A-10; miniature panel-mounted integrator-indicator presented in 4-page catalog 55-30; pneumatic instruments for gas sp gr measurement discussed in 4-page catalog 14-A-12; construction, installation and design features of remote, miniature, pneumatically-operated indicator explained in 12-page catalog 55-10. Each of the above is illustrated and contains full spec listings. Fischer & Porter Co, Hatboro, Pa.

PIPING, VALVES, SPECIALTIES

52 **Diaphragms,** gasketing, sheet packing, oil seals, rod and valve stem packings, etc featured in 8-page, 2-color booklet dealing with *Silicone* rubber products. Bulletin AD-147, Garlock Packing Co, Palmyra, N. Y.

53 **Tubular equipment** operation at elevated temperatures and pressures covered in new data card. Detailed specs on full range of seamless and welded carbon, alloy and stainless steel tubing and piping. TDC 154, Babcock & Wilcox Co, Beaver Falls, Pa.

54 **Standard nut and bolt** dimensions and thread specs given in new data sheet. Murphy Diesel Co, 5317 W Burnham St, Milwaukee 14, Wis.

55 **Cutless** rubber bearings and their various applications discussed in 32-page catalog. Photos, dimensional drawings, full specs. Lucian Q Moffitt, Inc, 333 S Main St, Akron, Ohio.

56 **Bronze** gate valves described in two folders. Photos, application data, full specs for various valves included. Lunkenheimer Co, Box 360, Cincinnati 14, Ohio.

57 **High-pressure** tube and pipe fittings presented in 28-page, 2-color catalog. Photos, dimensional drawings, full specs. Catalog 553, Flodar Corp, 1394 E 45th St, Cleveland 3, Ohio.

58 **Pocket-size** directory supplies name, street address, phone number of 32 Cooper Alloy stainless steel valve and fitting distributors. Cooper Alloy Fdry Co, Hillside, N. J.

PRIME MOVERS & ACCESSORIES

59 **Gasoline engines** for stationary, automotive and marine applications covered in 6-page, 2-color folder. Photos, cutaways, exploded views and full specs on horizontal and vertical models of 404, 451, 477 cu-in displacement. Bulletin L-7696, Twin Coach Co, Kent, Ohio.

60 **V-type diesel** engines of 12 and 16 cylinders ranging from 2400 to 4260 hp described in 8-page release. Photos, cutaway views, full specs incl. Bulletin 197, Nordberg Mfg Co, Milwaukee 1, Wis.

61 **Diesel engines,** ratings and descriptions and typical installations presented in 48-page booklet. Photos and specs incl. Murphy Diesel Co, 5317 W Burnham St, Milwaukee 14, Wis.

PUMPS

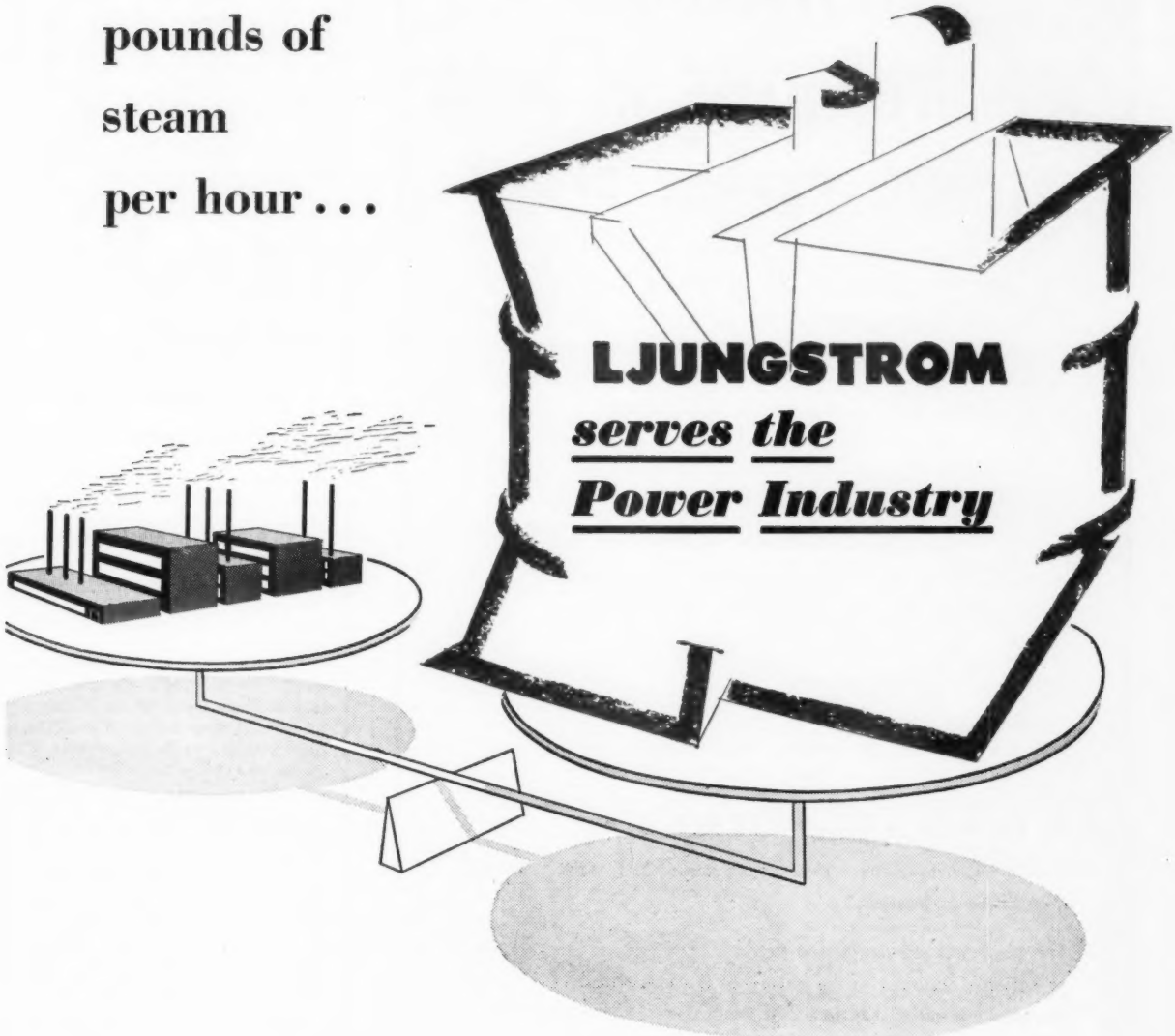
62 **Hollow and solid-shaft** vertical pump motors described in 4-color bulletin. Cutaways and phantom drawings show details and specific features of motor construction. Bulletin 1250, Louis Allis Co, Milwaukee 7, Wis.

63 **Packaged** pumping, heating and straining units for fuel oil presented in 8-page, 2-color booklet. Photos, dimensional sketches and assembly and installation drawings included. Bulletin 16H, Schutte & Koerting Co, Cornwells Heighs, Bucks County, Pa.

64 **Control systems** for protecting high capacity centrifugal boiler pumps during low load conditions treated in 8-page release. Full specs for each control system and its components. Bulletin S-53, Republic Flow Meters Co, 2240 Diversey Pkwy, Chicago 47, Ill.

347,000,000

pounds of steam per hour . . .



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► The thermostat on our Bunker C fuel-oil preheater went bad one evening while I was on watch. It was set to maintain oil temperature at 210 F but oil was leaving the heater at 150 F.

The vapor-filled thermostat bulb was installed in a manifold in the main oil line. Manifold pressure was 250 psi.

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● What is your "biggest boner"? We'll pay ten dollars for each one we publish.

National Association of Corrosion Engineers will cooperate in three short courses to be held in the remainder of 1953. Also, two short courses are contemplated on the West Coast and another for February 1954 at Washington State College. Some universities have instituted such corrosion courses and others have them under consideration.

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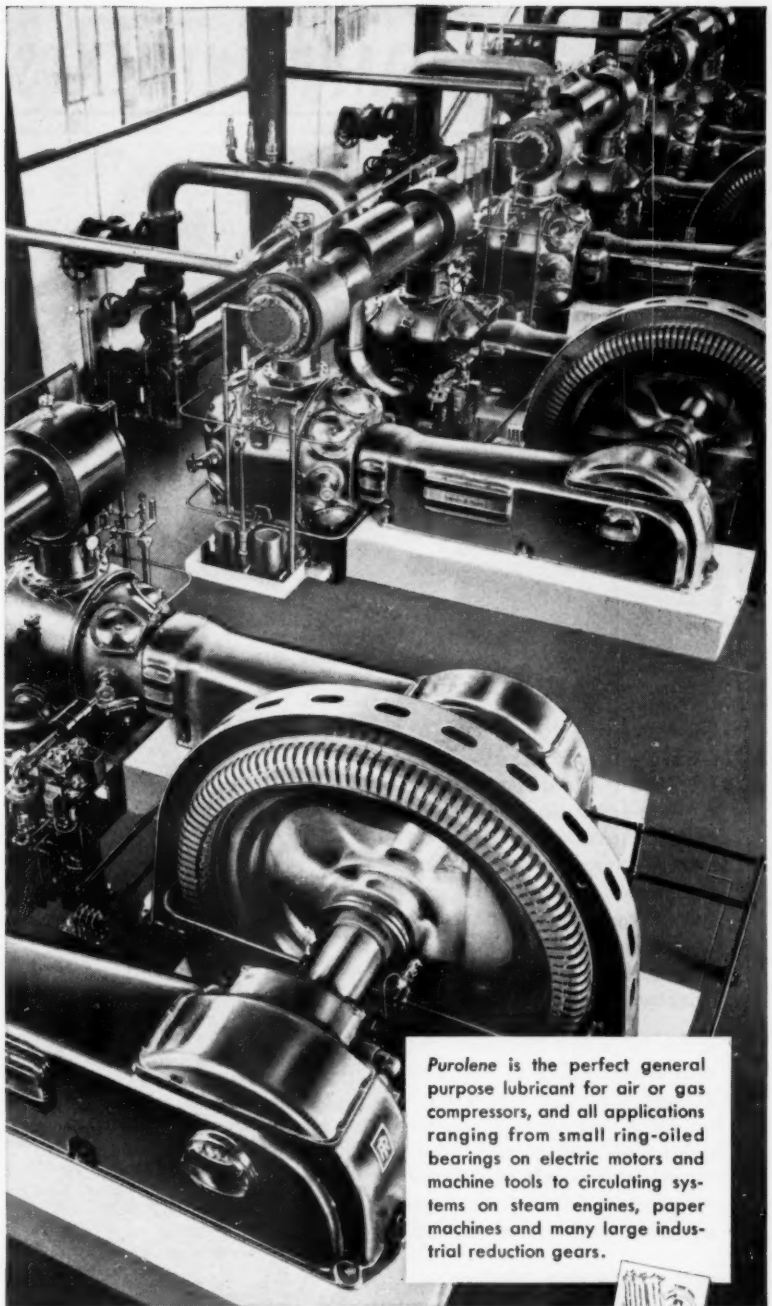

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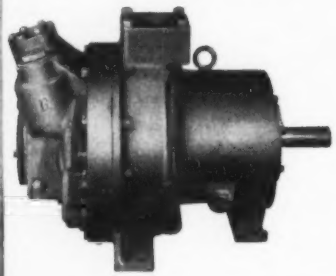

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APPOINTMENTS

Matthew M Lawler

Corporation Executive Changes

Chain Belt Co of Milwaukee: J C Merwin, from president to chairman of the board; L B McKnight from executive vice-president to president. **Raybestos-Manhattan, Inc:** J H Matthews, from vice-president to executive vice-president. **Revere Copper & Brass, Inc:** James M Kennedy, from president to chairman of the board; C A Macfie, from general sales manager to president. **Canadian Nickel Co, Ltd:** Ralph D Parker, from vice-president and a director to president.

Operations Executive Changes

Worthington Corp: Matthew M Lawler, from asst vice-president and manager to vice-president in charge of Air Conditioning and Refrigeration Division. **Borg-Warner Corp:** D E Gamble, chairman of the supervisory board of the Borg & Beck Division; T L Knecht, from vice-president and general manager to president of the division succeeding Gamble; George W Borg, from chairman of the supervisory board to chairman of the executive committee of the division. T J Ault, from vice-president and purchasing agent of Warner Gear to general manager of Detroit Gear Division.

Bechtel Corp: A J Orselli, from manager of construction for the eastern division to vice-president of the power division. **Clark Bros Co:** Robert J Spears, district manager for the New York office succeeding Robert R McCartney, now Eastern Division manager and director of export operations. **American District Steam Co, Inc:** James G Kintner, vice-president in charge of engineering.

Engineer Changes

Westinghouse Electric Corp: Robert C Cheek, from asst division sales manager to asst manager of engrg for Electronics Division, a newly-created post. **Trane Co:** Chester D Ware, heat transfer specialist in product development; Henry Hurwicz, spe-

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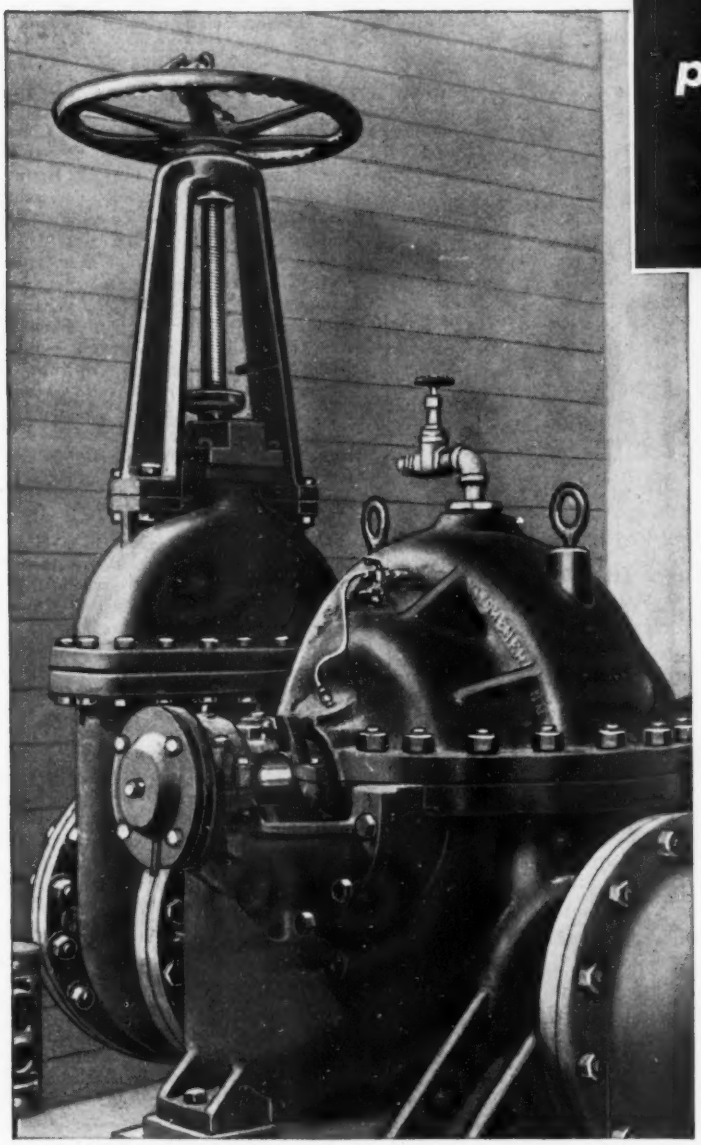

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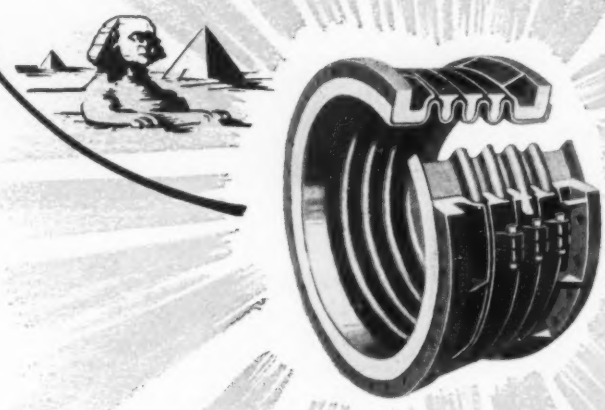

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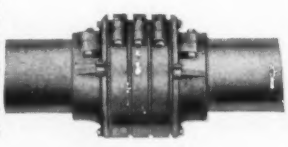

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More APPOINTMENTS

Begins on page 278

cial heat transfer development project. Walter Kidde Nuclear Laboratories: Dr Cecil B Ellis, head of Research Dept; Laboratory Division; J J Byrnes, head of Engrg Dept, Laboratory Division; Karl Puechl, head of Theoretical Dept, Development Division. Solar Aircraft Co: Frank J Hodnick, ceramic research engineer.

New Sales Managers

Norton Co: Edmund H Gagnon, Cleveland warehouse and sales office; Everett M Story, Hartford office. **Potter & Brumfield:** D J Fagge, Washington DC sales office; G W Moler, from Washington DC office to general sales manager. **Allis-Chalmers Mfg Co:** H R Wilson, from Indianapolis district office representative to manager of Rockford, Ill. branch office.

General Electric Co: R H Jackson, Southeastern District of Apparatus Sales Division. **Graybar Electric Co, Inc:** A P Torros, from Outside Construction and Power Apparatus Sales for Jacksonville district to manager of the Tampa branch. **Minneapolis-Honeywell Regulator Co:** Fred Kaiser, from field sales manager to manager of the Eastern region.

DeLaval Steam Turbine Co: Arthur L Foltz, Detroit district office. **U. S. Rubber Co:** G J Russ, general sales manager—a new post; A N Reeves, branch sales; R J Thomas, distributor sales; A Eaton-Clarke, head office and government sales. **Bristol Co:** F W Borchers, from asst sales manager to general sales manager.

New Sales Engineers

Cooper-Bessemer Corp: John Alcorn, foreign sales office; R L Moore, Chicago office. **Norton Co:** Allen C Moore, from Detroit office to western Michigan area; Harlan W Cobb, Cleveland area; Philip H Threshie, San Diego and Arizona area; Robert P Cooper and Robert N Hamilton, Los Angeles area. **DeLaval Steam Turbine Co:** Walter F Senkus, turbine and power plant equipment sales in the midwest region.

U. S. Hoffman Machinery Corp: Arthur E Poole, metropolitan New York-northern New Jersey area; Ralph Eads, Houston-southern Texas area. **Allis-Chalmers Mfg Co:** Ralph W Buchmueller, Peoria, Ill. office; Bruce F Campbell, Washington, DC office; John Ernst Jr, Milwaukee office; Harry Falck, Los Angeles office; Rudolph J Kristoff, Jackson, Mich, office. **Reliance Electric & Engrg Co:** Garvin L Jones, Newark office; Thomas J Lisy, Pittsburgh office. **Laclede-Christy Co:** Paul Ascenzo, New York territory.

New Distributors

For **Elgin Softener Corp:** G F Sterne & Sons Ltd, Brantford Canada. For **Boston Woven Hose & Rubber Co:** LeValley-McLeod, Inc of Syracuse, N. Y. For **Multi-Amp Corp:** Westinghouse Electric Supply Co of N. Y. For **Republic Mfg Co** of Cleveland: Florida Metals, Inc of Tampa,

IDENTIFICATION DISC: An aluminum marking plate on all Walworth No. 225P's facilitates inventory control and makes reordering quick and positive.

take a good look at the Walworth "500 Brinell" no. 225P Globe

NEWLY DESIGNED HANDWHEEL: Patented air-cooled, finger-fit handwheel affords sure grip even with greasy gloves.

– the Toughest Bronze Valve Your Money Can Buy

The stainless steel, corrosion resistant seats and discs are heat treated to a hardness of 500 Brinell – hard enough to scratch glass and crush nails! The valve can be closed on sand, slag, and pipe scale without injury to the seating surfaces. "Wire drawing" is practically eliminated. All parts are accurately machined and gaged. Years of tight, positive shut-off are assured.

Available in both globe and angle types (angle type: No. **227P**) in sizes ¼" to 2", this quality valve is recommended for 350 lbs. W.S.P. at 550 F, and 1000 lbs. non-shock service on cold water, oil, gas, or air.

For full data on this long-life, economical Walworth Bronze Valve, see your local Walworth distributor, or write for Circular.

IMPROVED PACKING: Molded packing of lubricated asbestos reinforced with copper wire. Suitable for practically every service. Valves can be repacked under pressure when fully opened.

note these 7 Great Features

HEXAGONAL UNION BONNET CONNECTION, DEEP STUFFING BOX AND RUGGED STUFFING NUT: Union bonnet connection eliminates any chance of distortion or leakage even though valve is repeatedly taken apart and reassembled.

OVERSIZE STEM: The high-tensile strength silicon-bronze stem assures long life and protection against wear.

SEATS AND DISCS: Plug type seats and discs of stainless steel, heat-treated to 500 Brinell hardness and machined simultaneously to a mirror-like finish, with accurate tapers assures tight positive shut-off with minimum handwheel effort.

EXTRA STRONG BODY: Made of Composition M (ASTM B61) bronze. Thick walls and rugged hexes provide a high safety factor. Valves undergo hydrostatic shell test of 1,000 psi.

WALWORTH

valves and fittings

60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Famous Pittsburgh firm uses FRICK Refrigeration 35 years, and finds it very dependable

The D. L. Clark Company, manufacturers of the world famous Clark Bar, and Clark Brothers Chewing Gum Company now operate eight large Frick refrigerating machines in their Pittsburgh Plants. The first of these compressors, installed in 1918, is still in service. Other Frick equipment includes condensers, coolers and controls.

Today, Clark Bars and Clark's Teaberry Gum are famous the world over. Frick air conditioning and cold storage systems play a vital part in maintaining the quality of all Clark products.

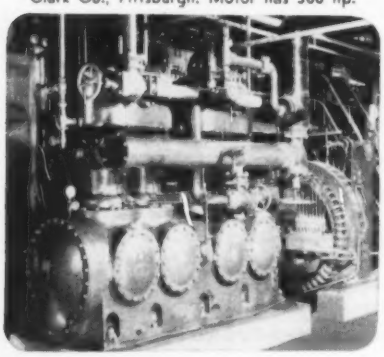
There's hardly a business that cannot profit from the use of similar Frick cooling equipment.

Let us quote on the system YOU need.

DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA. U.S.A.

Also Builders of Power Farming and Sawmill Machinery

Frick 4-cylinder ammonia compressor at D. L. Clark Co., Pittsburgh. Motor has 300 hp.



More APPOINTMENTS

Begins on page 278

Jacksonville and Miami; E D Sweetland Co of San Francisco; Pace-Turpin & Co of Salt Lake City; Palmer Supply Co of Seattle.

New Representatives

For **U. S. Rubber Co:** Earley Sales Co of Paterson, N. J.; For **Copes-Vulcan Division** of Continental Fdry & Mach Co: C H Spencer & Co of Salt Lake City. For **John Hewson Co:** H E Ransford Co of Pittsburgh; Thomas A Collier Co of Philadelphia. For **Precision Transformer Corp:** Alton M Johnson Co of Minneapolis and L H Benesh Co of Bettendorf, Iowa.

New Branch Offices, Warehouses, Etc

Clark Bros Co, Division of Dresser Operations, Inc: service office in Fox Bldg at 1612 Market St, Philadelphia under Ralph C McDonald. **U. S. Rubber Co:** branch warehouse at 4800 Colorado Blvd, Denver, Colo. **Boston Woven Hose & Rubber Co:** branch warehouse at 685 Metal Rd NE, Atlanta, Ga. under Terry Hayden.

Recent Purchases, Mergers, Etc

Charles T Main, Inc: all business of John A Stevens, Inc of Lowell, Mass. **Otis Elevator Co:** Transmitter Equipment Mfg Co; TEMCO will remain in operation long enough to fill existing contracts. **Chain Belt Co:** all facilities and business of Shafer Bearing Corp. **Youngstown Sheet & Tube Co:** an interest in Perrault Fibercast Corp. **Bassick Co:** production tools and inventory of finished goods and parts in process of manufacture of the industrial caster and wheel line now made by Killbourne & Jacobs Co. **General Supply Co** of Cleveland: unification of facilities with Singleton Co.

Obituaries

Fred Kalmbach, Sr. 73, chairman of the board of General Machine Co and of Electric Furnace-Man, Inc, July 31.

Philip Torchio Jr, 45, commercial vice-president of American Gas & Electric Service Corp of New York, August 9.

Gaylord B Buck, 59, vice-president and commercial manager of Public Service Co of Colorado, August 2.

C E Bramble, 61, vice-president and treasurer of California-Pacific Utilities Co, July 15.

E Parish Lovejoy, 53, former executive of Detroit Edison Co, August 14.

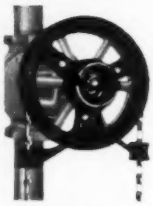
Harold J MacDonald, 54, government sales manager for U. S. Rubber Co's electrical wire and cable dept, August 19.

"Weathertron" and "Weathertronics" will be the new names applied to General Electric's heat pump and activities in the heat pump field. Also, the old Heat Pump Dept will be known as *Weathron* Dept.

Cut-Out "LADDER RISK" with...

Babbitt Adjustable SPROCKET RIM with Chain Guide

Overhead valves, whatever their position, are always within reach — when you control them right from the floor! No need for climbing ladders, perching on boilers, balancing on workbenches or machines. Avoid accidents — and costly claims. Note these particular advantages of Babbitt Adjustable Sprocket Rim with Chain Guide:



- **Positive, efficient valve control**
- **Saves money on fuel and steam**
- **Does away with accidents**

Four simple, quickly assembled parts, quickly installed — in range of 10 adjustable sizes to fit all valve wheels from 2 to 30 inches diameter, with rising or non-rising stems.

Call your Industrial Distributor. He carries complete stocks. Or write for descriptive folder and prices.

Babbitt STEAM SPECIALTY CO.
2 BABBITT SQUARE, NEW BEDFORD, MASS.

POWER'S "ATOMIC ENERGY TODAY"

—condenses the reports of four industry teams on actual plans and costs for atomic power plants.

—makes these reports understandable with a 4-page refresher course on nuclear fission.

This is what the busy engineer needs to know about atomic energy today.

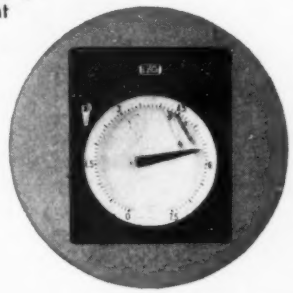
16 pages. Profusely illustrated. 30¢ per copy. Less for quantity orders.

POWER 330 W. 42 St. New York 36, N. Y.

Measures fundamental indicator of combustion efficiency—Oxygen. Applicable to power plants and process problems like catalytic crackers, open hearths, process heaters, inert gases, etc.

PRINCIPLE — Based on paramagnetic (attracted by magnetism) properties of Oxygen.

FEATURES — Highly sensitive to change in 0_2 content — responds rapidly. Electrically operated. Electronic type recorder. Temperature controlled. Pressure compensated. No liquid or gaseous fuel required. No chemicals. Highly accurate. Not affected by wide change of gas flow rate. Continuous sampling and recording. Glass and corrosive resistant sampling system. Remote mounted analyzer and recorder. Four records on same chart possible. Low maintenance.

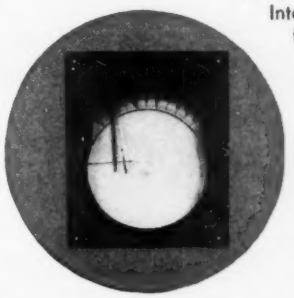


Hays Magnotherm O_2 Meter

Provides a *QUANTITATIVE* guide to efficiency — deals with quantities of air and steam; by contrast CO_2 and O_2 meters are *QUALITATIVE* guides since they determine directly quality of combustion gases.

PRINCIPLE — Record of steam flow is assumed to be Btu's produced; record of air flow is calibrated to flow of air required to generate that steam.

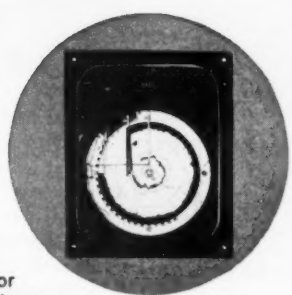
FEATURES — Electric operation of flow meter and air flow recorder. Diaphragm-type air flow measuring unit. Air flow measuring element does no work. Air flow recorder—motor operated. Adjustable cam air flow calibration. Mercury transmitter — pressures to 2500 psi. Interchangeable range tubes for steam flow. Remote mounted steam flow transmitter. No high pressure piping into panel. Easily installed and adjusted. Low maintenance.



Hays-Penn Boiler Efficiency Meter

Which combustion guide is best?

IT DEPENDS . . . on the fuel you're burning, the accuracy you require, the price you want to pay, etc. Your particular needs will determine your choice . . . but remember—only Hays can supply you *without bias* . . . because only Hays has a *complete* line of Combustion Guides.

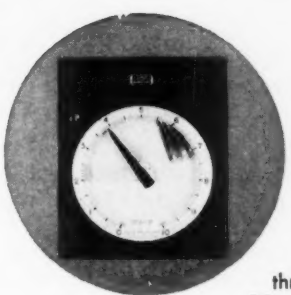


Hays Combustion Meter

Hundreds of these meters have been in operation for many years in all types of plants burning all kinds of fuels and saving thousands of fuel dollars.

PRINCIPLE — Operates on Orsat principle of volumetric measurement and chemical absorption. Difference in sample before and after absorption gives exact percentage of CO_2 absorbed by chemical.

FEATURES — Low price. Water operation. Pressure and temperature compensated. Volumetric determination. Chemical absorption. 2-minute operating cycle. Easily understood. Rugged construction. Low maintenance. Available in 6 remote mounted types and 3 integral types: (a) CO_2 only—recording with or without indicator (b) CO_2 and flue gas temp. recorder combined (c) CO_2, draft or flue gas temp. recorder combined. Remote or integral mounting.



Hays Condu-Therm CO_2 Meter

A *new* instrument using three *established* ideas: (1) CO_2 as guide to combustion efficiency (2) thermal conductivity principle (3) electronic type operation.

PRINCIPLE — Based on thermal conductivity of gases, i.e., that all gases conduct heat at different rates.

FEATURES — 5-second response to change in CO_2 content. ± .25% accuracy for ranges 0 to 20%. Electrically operated. Electronic type recorder. Temperature controlled. Humidity controlled. No chemicals required. No moving parts in analyzer. Continuous sampling. No drying agent required. Unmatched construction features. Not affected by wide change in gas flow rate. High sensitivity. Rapid response Continuous recording. Remote mounted analyzer and recorder. Low maintenance.

THE HAYS CORPORATION

MICHIGAN CITY 3, INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

Safeguard

WORKERS
PLANT
PRODUCTION

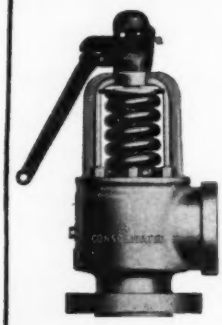
Specify

CONSOLIDATED
SAFETY VALVES

The dependability and high performance standards of Consolidated Safety Valves assure maximum protection of employees, plant facilities and production. Proved in thousands of installations during the past 75 years, these spring-loaded valves provide high discharge capacity, positive and tight closing after operation.

The capacities of all Consolidated Safety Valves are guaranteed and proved by flow measurements. A 2100-pound design boiler, used exclusively for testing and setting, is further assurance that Consolidated Safety Valves are the best protection available.

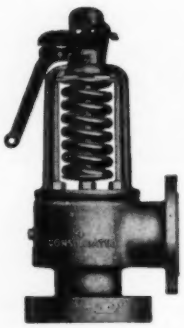
Whatever your working pressures and temperatures, the complete line of Consolidated Safety Valves makes selection easy for your particular needs. They have few working parts, are tough, and require little maintenance throughout their long service life. Full information, including safety and service feature data, are yours on request. Write for Catalog 700.



TYPE 1411 IRON BODY SAFETY VALVE

Sizes:
1½" through 6"
Pressures:
Up to 250 P.S.I.
Temperatures:
Up to 450°. F.
Standard Connections:
Threaded or flanged.

Designed with a bevel seat, single ring blowdown control and a one-piece feather (disc), this high capacity, wing guided valve incorporates every feature essential to complete dependability, positive protection and ease of maintenance. Recommended installations include water tube boilers, mechanically fired fire tube boilers, accumulators, unfired pressure vessels and pipe lines within its rated capacity. All sizes available with oversize inlet flanges for replacement purposes.



TYPE 1415 STEEL BODY SAFETY VALVE

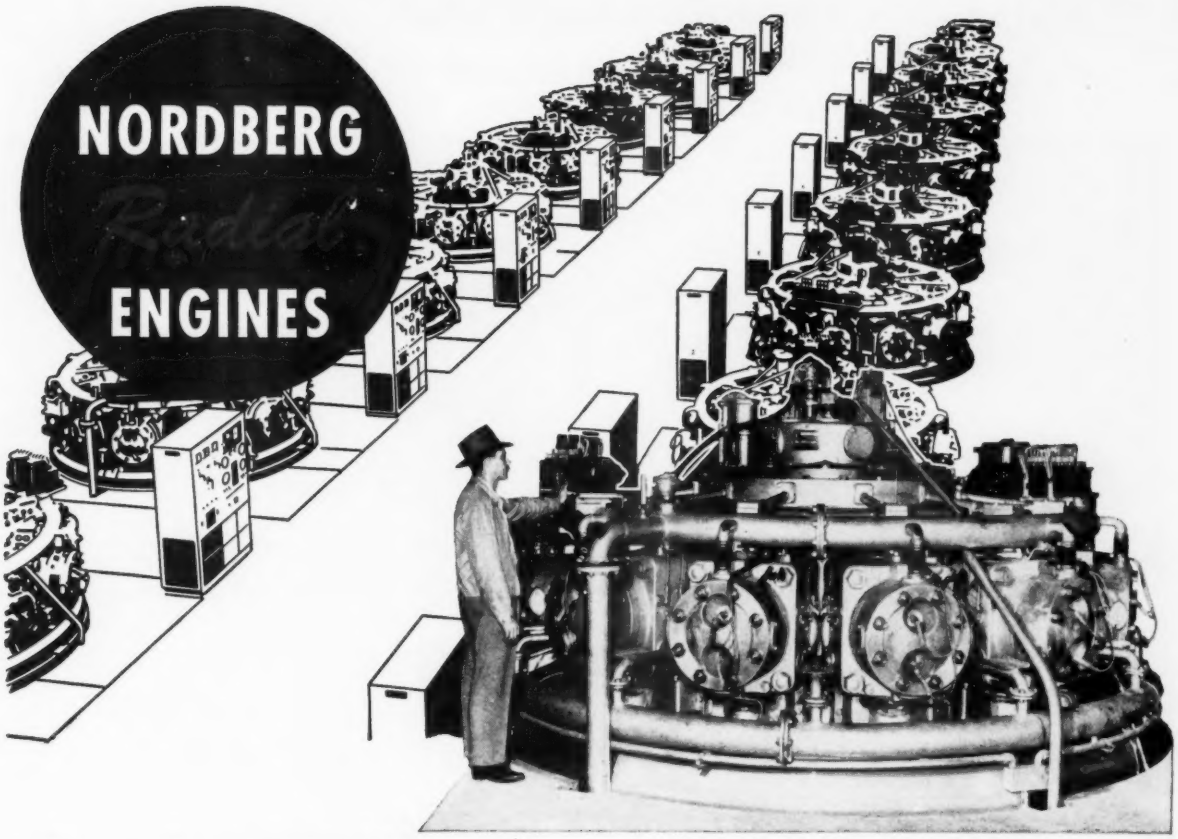
Sizes:
½" through 6".
Pressures:
Up to 600 P.S.I.
Temperatures:
Up to 900° F.
Standard Connections:
Flanged.

Body is cast steel. Has a high erosion and corrosion resistant stainless steel seat bushing **seal welded to the base.** Recommended for all applications beyond the scope of its companion valve in cast iron, Type 1411 shown above. It is a high capacity wing guided valve with fully exposed spring—a rugged, dependable and economical valve proved in thousands of field installations. Available with oversize inlet flanges.

CONSOLIDATED SAFETY VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.



Supply Reliable, Compact, Low Cost Power

• NORDBERG 2-CYCLE RADIAL ENGINES develop 1950 to 2125 hp. or 1250 to 1500 kw. at 400 rpm.

Applicable for municipal and industrial power plants and central stations . . . wherever compact, economical, dependable power is required. *For full details, send for Bulletin 200.*

NORDBERG Radial Engines (*Diesel, Duafuel® —Spark-Fired Gas*) offer an unusual combination of design and operating advantages which make them ideally suited for continuous heavy duty power service. *Compare these basic advantages:*

☆ COMPACT DESIGN

☆ EFFICIENT OPERATION

☆ LOWER STANDBY COST

☆ MINIMUM MAINTENANCE

☆ PROVEN DEPENDABILITY

☆ LOWER BUILDING COSTS

☆ SHIPPED AS A COMPLETE UNIT

NORDBERG MFG. CO., Milwaukee, Wisconsin

NORDBERG

DIESEL • DUAFUEL® AND SPARK-FIRED GAS ENGINES

P453

Straight Tube
U-Tube
Horizontal
Vertical
Condensing
Subcooling
Desuperheating
High Pressure
Low Pressure
Large Capacity
Small Capacity

at our finger-tips

the right feedwater heater design for your needs

No matter what may be your capacity needs, your boiler pressure, your plant heat balance, or your special operating conditions, you can be sure that G-R can supply a practical, effective design of feedwater heater precisely suited to your needs.

That's because of the 65 years of G-R experience in building feedwater heaters, throughout which the G-R designs have been steadily developed to keep abreast of advances in steam plant practice.

And here's another important result of this unequalled G-R experience . . . the many proven exclusive design features that assure long, economical service as well as highly efficient heat transfer.

Write for bulletin describing in detail the many types and advantages of these units.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

G-R HEAT TRANSFER APPARATUS **Feedwater Heaters**

GR292

WHEREVER rigid piping must be connected to machinery

USE CMH FLEXIBLE METAL HOSE

YOUR GUIDE TO MOTION CONTROL

Catalog 130 gives specifications for all types of CMH hose. Write for a copy or see the Flexonics catalogs in Chemical Engineering Catalog and Sweets Plant Engineering File.

By using CMH Flexible Metal Hose as the connecting link between rigid pipe and machinery, you solve two otherwise serious problems—the elimination of damage to the piping because of vibration and the compensation for any misalignment that may exist. Properly installed, CMH Flexible Metal Hose will give long, dependable, trouble-free service without further attention.

Whatever your flexible connection problem, there is a CMH hose type to meet your needs. Corrugated and convoluted types are available in a wide variety of designs and in a complete range of sizes. CMH Flexible Metal Hose is offered in steel, bronze, stainless steel and other alloys to fill your requirements. Your Flexonics distributor will give you further data. Look for his name in your classified telephone directory or we will be pleased to send it to you.

Flexon identifies CMH products that have served industry for over 50 years.

CMH

CHICAGO METAL HOSE Division

Flexonics Corporation 1301 South Third Avenue, Maywood, Illinois

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexible metal hose

Expansion joints.

Aircraft components

Metallic bellows

TORTURE CHAMBER

for VALVE and FITTING MATERIALS

Here, steam up to 1500 pounds pressure and 1000° F. gives Vogt the answer to any question of materials or construction for valves and fittings in just a few days . . . facts that would take years to obtain under normal operating conditions!

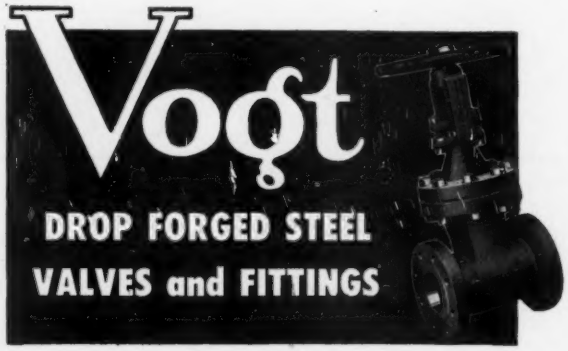
We set up our own Torture Chamber to determine the durability of valve packings and gaskets; the resistance of various steels to corrosion and erosion; and how hard and how smooth surfaces of seats, discs and stems must be to withstand steam at high pressures and high temperatures. We tested and found an ideal yoke nut material, and we uncovered facts on joint design that could be found in no other way.

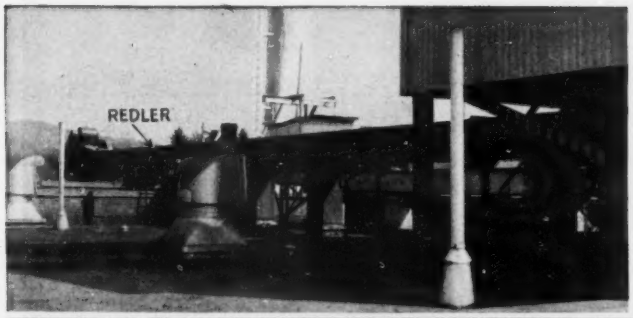
Thus, by constant and accelerated testing, we quickly and definitely prove or disprove the claims that are made for many newly developed materials. And thereby we make sure that only the best goes into valves and fittings that bear the name Vogt.

Consult Catalog F-9 for the complete Vogt line of drop forged steel valves, fittings and flanges for steam, water, oil, gas, air and refrigeration services.

HENRY VOGT MACHINE CO., Louisville 10, Ky.

BRANCH OFFICES: NEW YORK • CHICAGO • CLEVELAND
PHILADELPHIA • ST. LOUIS • DALLAS • CHARLESTON, W. VA.





ECUSTA PAPER CORPORATION, Pisgah Forest, N. C.
Coal from track hopper is elevated by an S-A Pan Feeder to a double rotor Knittel Crusher. An S-A Belt Conveyor then takes it to the transfer house. Here it is discharged to another belt conveyor or to yard storage for later reclaiming by pan feeder from storage hopper. The second conveyor carries the coal to the roof of the boiler house and discharges it to a horizontal REDLER Conveyor that discharges through seven openings. An S-A Tellevel control at the head end of the REDLER prevents jamming. The System can handle 75 tons per hour.

S-A CONVEYING *Systems* handle coal in flexible flow

...HIGH volume at LOW cost per ton

Belt Conveyors
REDLER Conveyor-Elevators
ZIPPER Conveyor-Elevators
Weigh Larries
Crushers, Roll and Ring Type
Bucket Elevators
Pivoted Bucket Carriers
Screw Conveyors
Skip Hoists
Belt, Pan & Plate Feeders
Track Hoppers & Bin Gates
TELLEVEL Bin Level Controls
Water Intake Screens
SEALMASTER Ball Bearing Units

Write for a bulletin on any of the above

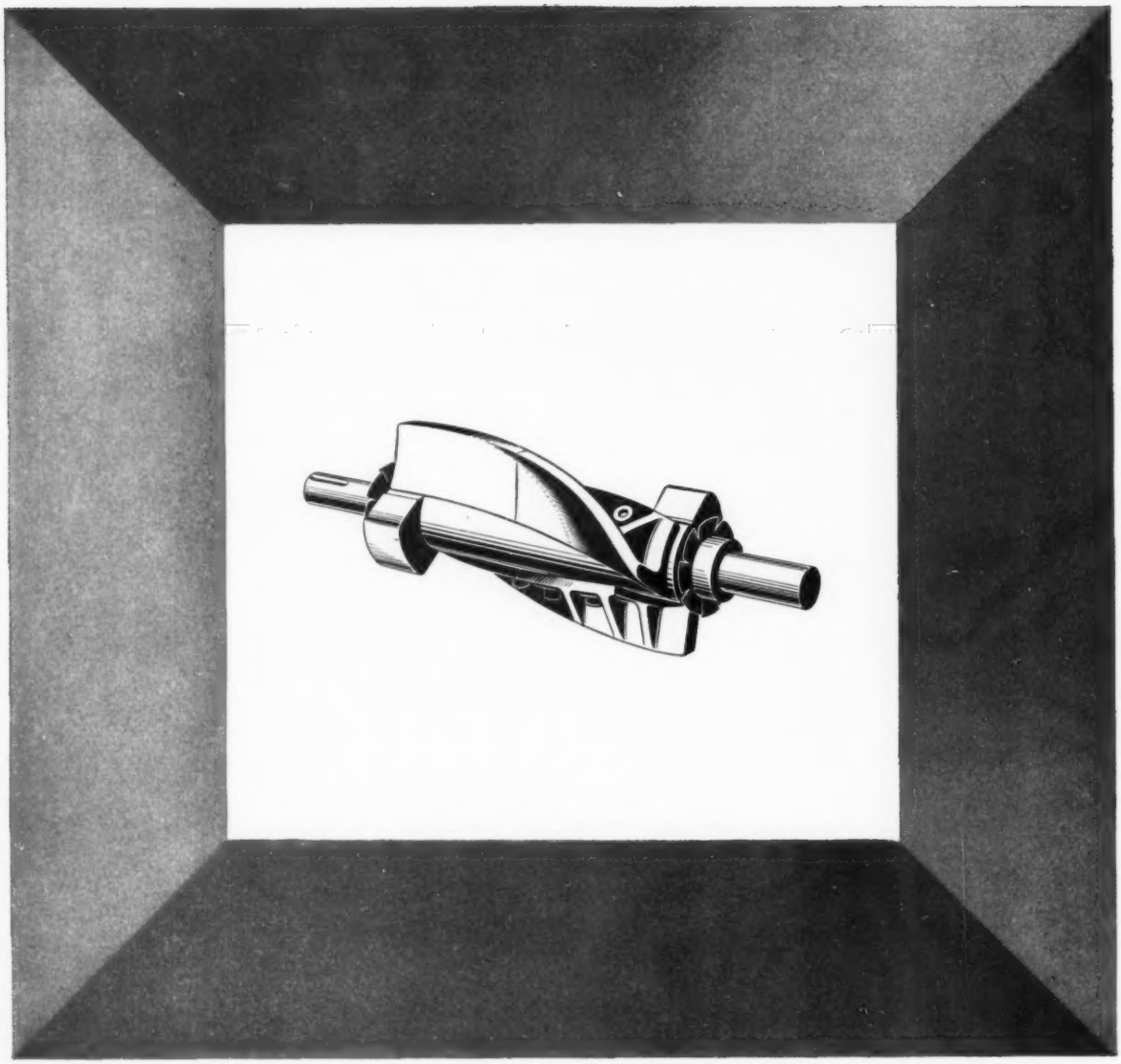
Cigarette paper, an extensive line of thin paper specialties, and Olin cellophane are manufactured in large volume at this plant. Expanding operations requiring new power facilities made this new coal handling system necessary. You see here S-A equipment that takes coal from the track hopper, crushes it, and delivers as needed to boiler house bunkers or yard storage. It also reclaims from storage—and does the whole job with a minimum of labor or supervision.

S-A engineers have earned a reputation for their efficient, economical solutions to *all kinds* of coal handling problems. Drawing upon a vast experience, plus the most complete line of bulk handling equipment, they can help *you* to find a profitable answer to your bulk handling problems. Write and we'll arrange a meeting.

STEPHEN S-A ADAMSON MFG. CO.

5 Ridgeway Avenue, Aurora, Illinois — Los Angeles, Calif., Belleville, Ontario

DESIGNERS AND MANUFACTURERS OF ALL TYPES OF BULK MATERIALS HANDLING EQUIPMENT



How to make a stoker with Perfect Spread

WHETHER YOU PLAN to buy a new unit or to re-stoker an old one, it must be engineered to assure top efficiency with both low and high ash coals. And a prime requisite for such efficiency is *even* coal distribution over the entire grate . . . the perfect spread that is provided only by American Engineering's unique spiral overthrow rotor.

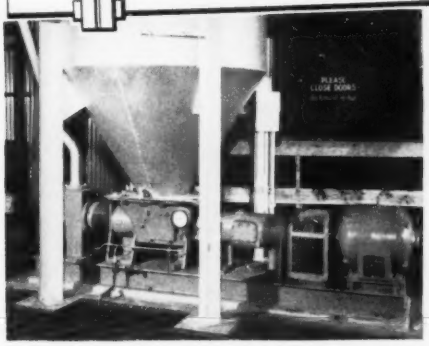
Supplementing that, you need the exclusive Perfect Spread traveling conveyor feeder that ***won't clog . . . not even on wet coal.*** This feeder operates on a high traction principle that provides true, *continuous* feeding throughout its whole range of 50 to 7500 lbs. of coal per hour. And for maximum combustion . . . most steam per fuel dollar . . . the special AE cinder return and adjustable overfire air system are unsurpassed.

Perfect Spread Stokers are available in a wide choice of sizes, capacities and grate types. Ask to have an American Engineering Company representative call and discuss your exact requirements.

AMERICAN ENGINEERING
COMPANY
2400 ARAMINGO AVE., PHILADELPHIA 25, PA.
IN CANADA: AFFILIATED ENGINEERING CORPORATIONS, LTD., MONTREAL 2, CANADA

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers.

fly-ash handling with fuller-kinyon system



Fuller screw feeder, discharging fly ash from Allen-Sherman-Hoff evacuating system.

at

DUQUESNE LIGHT COMPANY
ELRAMA STATION

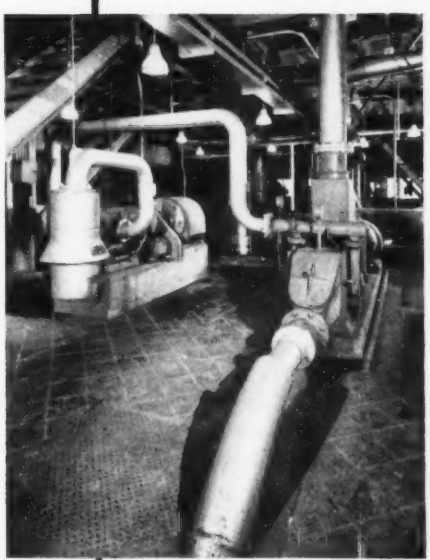
SAFE • CLEAN • EFFICIENT CONVEYING

Duquesne Light Company, Pittsburgh, Pa., Elrama Station, takes full advantage of the efficiency of the Fuller-Kinyon Conveying System for disposal of its dry fly ash from boilers.

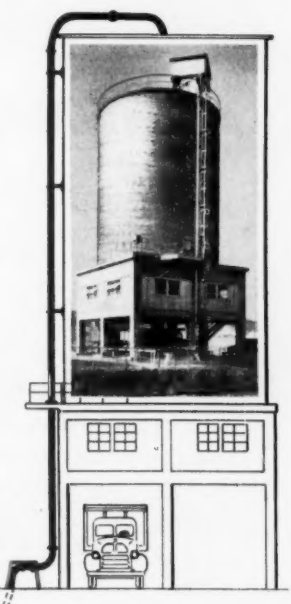
An Allen-Sherman-Hoff evacuating system discharges the fly ash to a Fuller screw feeder which, in turn, delivers the material, through a vertical pipe leading downwardly, approximately 100 feet, to a Fuller-Kinyon Pump on the ground floor of the boiler house.

The Fuller-Kinyon System conveys, underground, to a storage and loading silo in the yard, a distance of approximately 800 feet, at rate of 25 tons an hour. A Fuller Rotary Single-stage Compressor furnishes 763 c. f. m. of air at 30-lb. pressure to the Fuller-Kinyon Pump, through a direct-connected air line. Air, where and when needed, at the proper pressure to do the work required most efficiently and economically.

Air-conveying of dry, pulverized materials has had specialized engineering treatment at Fuller for twenty-seven years. Why not take advantage of this experience the next time you have a conveying problem? We'll be glad to work with you and give you the benefit of this experience.



Fuller-Kinyon Pump, right, conveying to storage. Fuller Rotary Single-stage Compressor, left, furnishes air for conveying.



FULLER COMPANY
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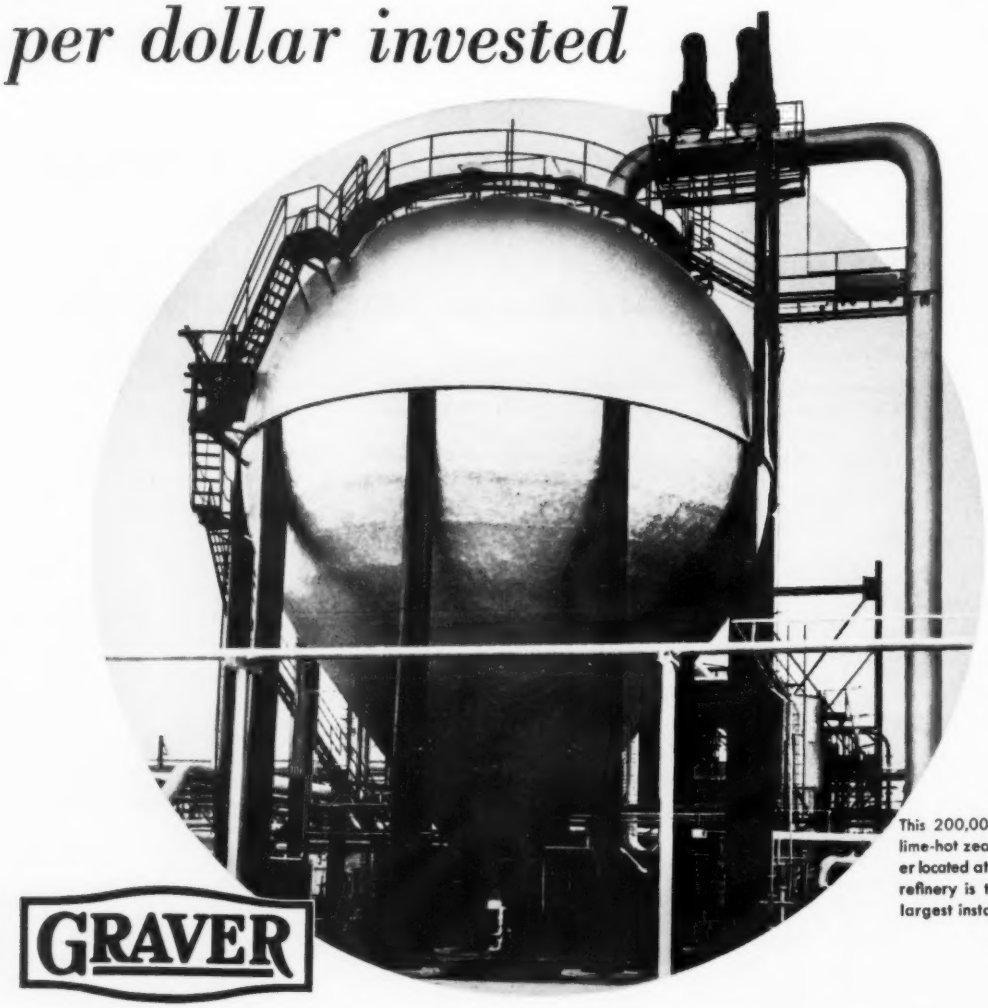
DRY MATERIAL CONVEYING SYSTEMS AND COOLERS—COMPRESSORS AND VACUUM PUMPS—FEEDERS AND ASSOCIATED EQUIPMENT

P-151
2173

Clearest Water per dollar invested



This 200,000 gph hot lime-hot zeolite softener located at an eastern refinery is the world's largest installation.

GRAVER

SPHERICONE *Hot Process Water Softener*

In hot process water softening, the clarity of the effluent depends, among other factors, on the rising rate of the water through the unit... the greater the cross-sectional area, the lower the rates ... the lower the rates, the lower the turbidity. This lower turbidity means fewer filter backwashings and the very lowest labor costs.

The Sphericone, a Graver original design, offers a larger cross-sectional area per pound of steel used, and consequently per dollar invested, than the standard cylindrical type of hot process softener.

The expanding settling zone and larger cross-sectional area provide crystal clear effluent at rates, in many cases, up to 20-30% overload. These features, plus the Sphericone's high efficiency in silica reduction by contact with MgO sludge in a deep, dense blanket, make it one of the most important developments in the hot process softening field.

GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

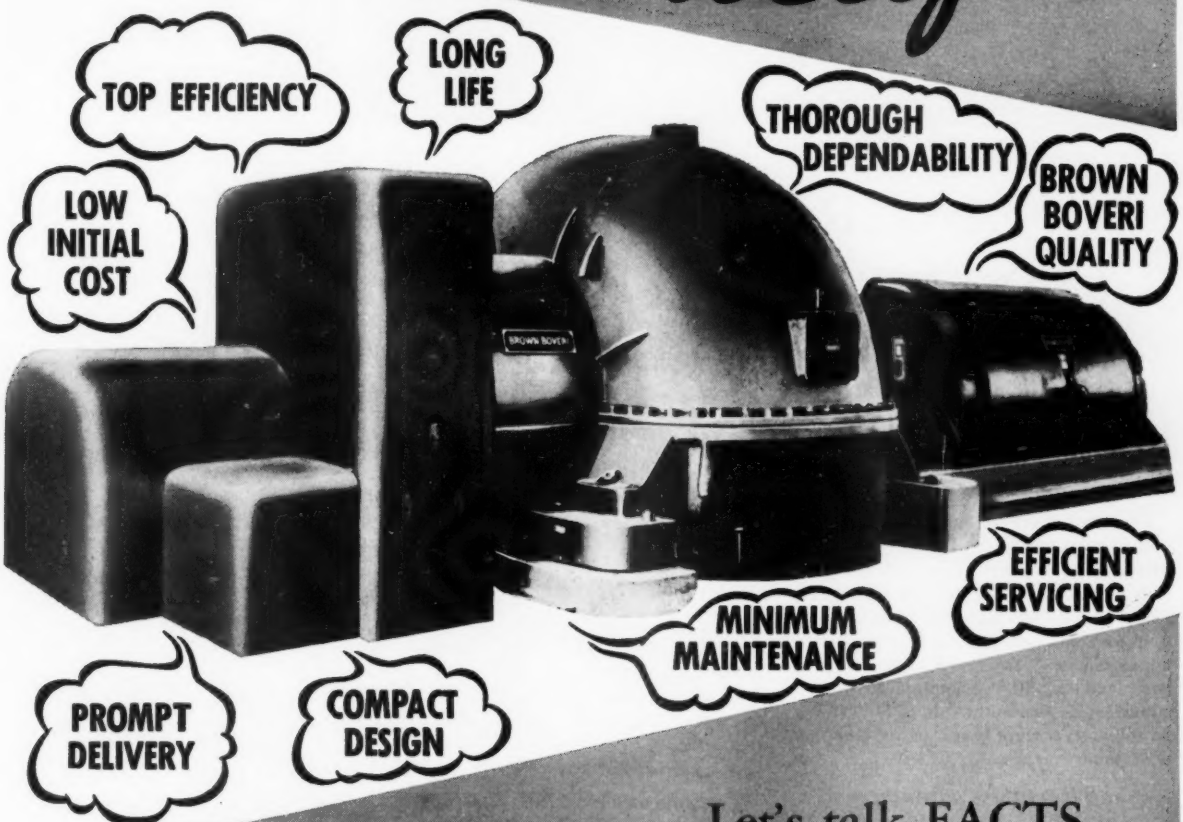
DEPT. P-HP, 216 WEST 14TH STREET, NEW YORK 11, N. Y.

In Canada: The Bird-Archer Co., Ltd., Cobourg, Ontario • In Mexico: Proveedores Tecnicos, S.A., Puebla 259, Mexico 7, D. F.

GW477

A BROWN BOVERI TURBO GENERATOR

Speaks for itself...



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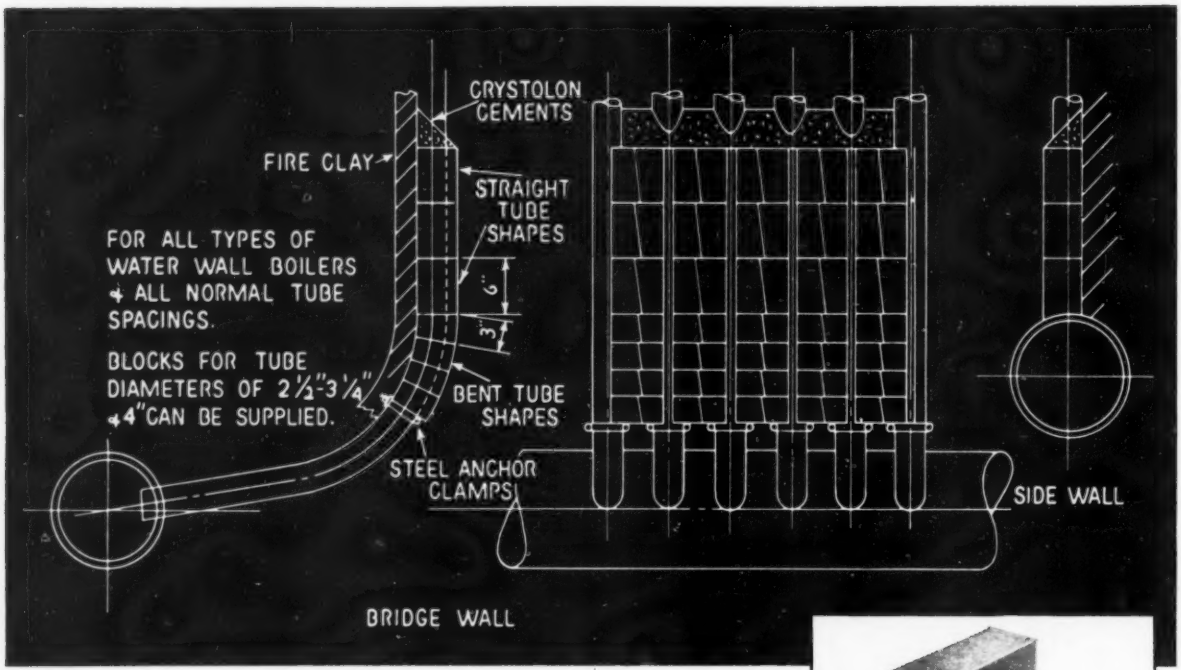
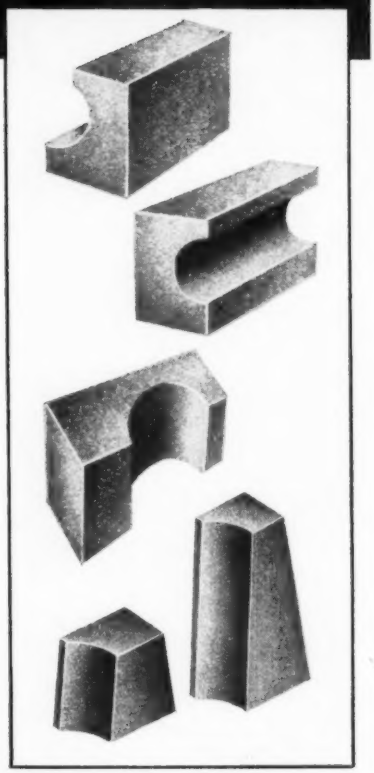

CRYSTOLON CEMENTS
FIRE CLAY
STRAIGHT TUBE SHAPES
FOR ALL TYPES OF WATER WALL BOILERS & ALL NORMAL TUBE SPACINGS.
BLOCKS FOR TUBE DIAMETERS OF 2½"-3¼" & 4" CAN BE SUPPLIED.
BENT TUBE SHAPES
STEEL ANCHOR CLAMPS
SIDE WALL
BRIDGE WALL

DIAGRAM FOR LONG BOILER LIFE

... and a formula for fewer shutdowns

CRYSTOLON* *Armor Blocks*



The way to get the most out of water tube boilers is to give them CRYSTOLON Armor Block protection.

CRYSTOLON Armor Blocks are made to afford maximum protection to tubes from localized heat generation and flame impingement. They're tapered for secure locking and to maintain intimate contact with the water tubes. They can be replaced readily from the fire side of the boiler.

You'll get these advantages

1. Ability to stand up under high heat (up to 3050°F).
2. Virtually impervious to slag penetration.
3. Practically clinker-proof.
4. Stand up under abrasion caused by the moving bed of stoker-fired furnaces.
5. Installation easy and inexpensive.

And when you need cement, call for Norton CRYSTOLON cement for laying up bricks — and for air-cooled wall construction. The time between shutdowns will be the greatest you have ever experienced.

Bulletin Sent Free

For more information about CRYSTOLON Refractories for Boiler Protection, write for Bulletin 862 NORTON COMPANY, 449 New Bond St., Worcester 6, Massachusetts.

Canadian Representative: A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

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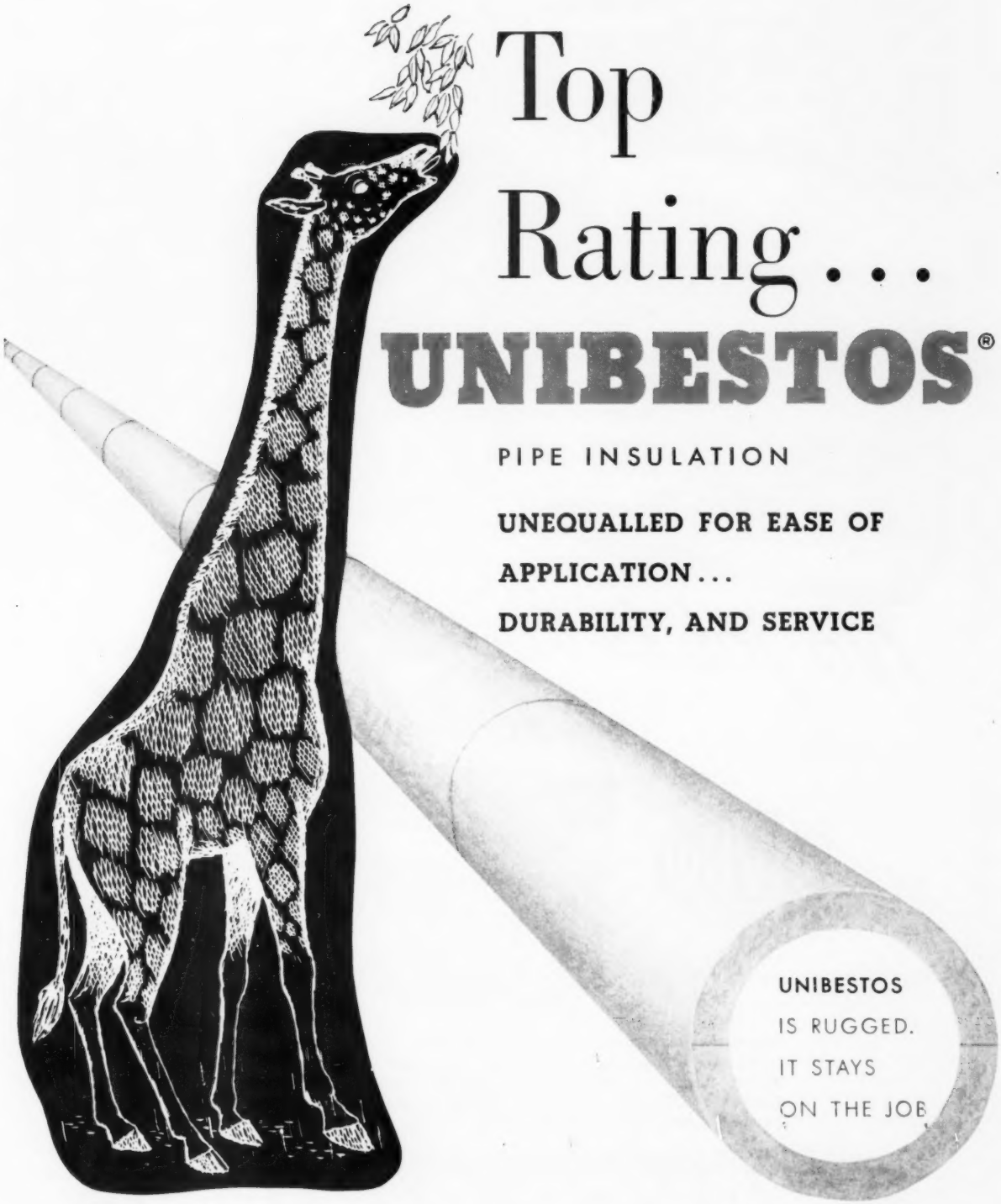
PIPE INSULATION

UNEQUALLED FOR EASE OF APPLICATION . . . DURABILITY, AND SERVICE



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No job is too unusual for NAVCO

Whether you require a simple pipe bend or a complicated prefabricated assembly Navco can help you. As shown above, Navco Shops are equipped to handle Chrome Moly, Stainless, Carbon Steel and Copper, in addition to any of the many other Ferrous and Non-Ferrous materials.

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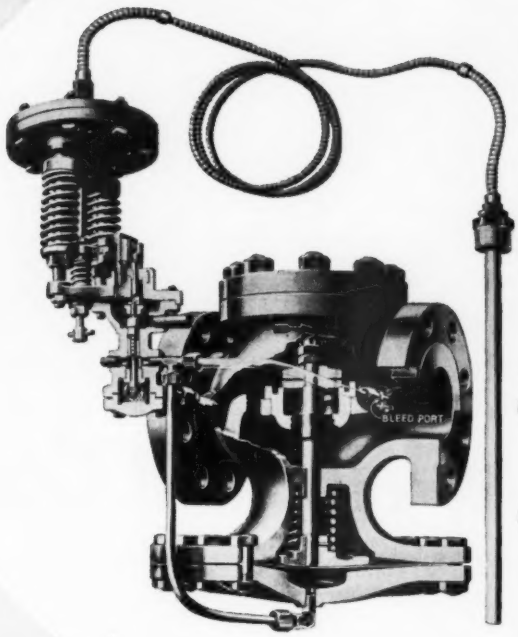


PACKLESS CONSTRUCTION

LARGE BALANCED METAL DIAPHRAGM

SENSITIVE PILOT

Spence

Packless construction eliminates the need for closely fitted parts that may stick or bind due to dirt or uneven expansion of the parts.

In Spence Temperature Regulators, the Main Valve is actuated by a large balanced metal diaphragm which responds to the slightest changes in temperature.

Sensitive Pilots are designed to limit heater pressure to an adjustable maximum. As the temperature at the thermostat drops a few degrees there is a corresponding increase in steam pressure up to the limit for which the Pilot is set.

With regulators that respond only to temperature, an increase in load is accompanied by a momentary decrease in steam pressure caused by faster condensation in the heating element. There is a time lag until the thermostat senses the temperature drop and opens the valve wider. Spence Temperature Regulators act like pilot operated pressure regulators when this occurs. They respond instantly to maintain the steam pressure until the thermostat has a chance to further increase it as needed for the heavier load.

These plus other design features explain why Spence Temperature Regulators function dependably and accurately year after year, without requiring extensive repairs or special attention.

Want more facts? Write for Bulletin T50 giving full details.

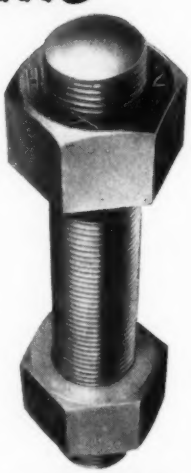
8K12B

SPENCE ENGINEERING COMPANY, INC., Walden, New York

Economy Where It Counts

Put this fastener team to work in bolting applications where temperatures and pressures run high, and you can count on economical service, with a minimum of down-time.

The Bethlehem Continuous-Thread Stud, used with two Bethlehem Quenched Nuts, makes an economical combination for high-temperature, high-pressure bolting, because of the way it resists premature fatigue failure.



Bethlehem Continuous-Thread Stud

The Bethlehem Continuous-Thread Stud gives long service because it minimizes stress-concentrations. There being no point of thread-runout on the stud, stresses cannot converge at any one point to cause premature failure. Instead, they are well distributed along the working length of the stud. The stud, made from carbon or alloy steels, is furnished either plain or heat-treated.

Bethlehem Quenched Nut

The Bethlehem Quenched Nut is made from 0.40 to 0.50 carbon steel by a process of forging and extruding hot steel in a forming die. It is then quenched and tempered, providing the nut with sufficient strength to develop the full strength of *any* stud or bolt with which it may be used.

The Continuous-Thread Stud and the Quenched Nut come in a full range of sizes. A letter or phone call to the nearest Bethlehem office will bring you full information.

BETHLEHEM STEEL

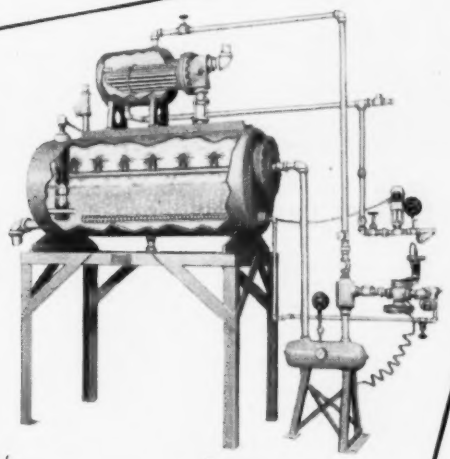
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

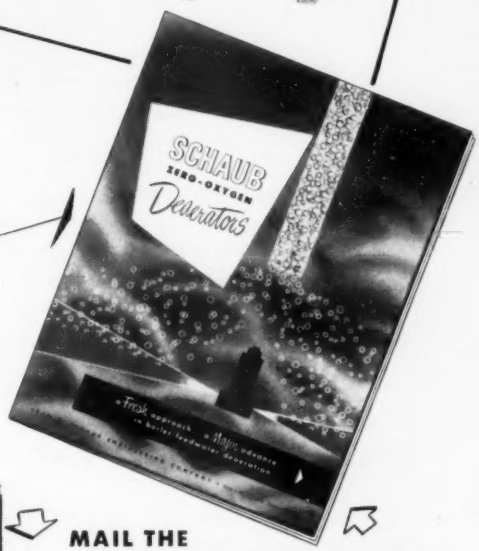
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

Bethlehem supplies every type of Fastener

A FRESH LOOK INTO *Deaeration!*

SCHAUB ZERO-OXYGEN *Deaerators*





ENTIRELY NEW

in operating principle

in mechanical design

in the advantages they offer

"Newness" for its own sake is no advantage in a deaerator. But when new thinking achieves improved performance not possible with conventional designs, it's worth looking into!

The Schaub Zero-Oxygen Deaerator differs from all others in that it provides *external* pre-heating to a temperature *above* boiling point, with over-atmospheric pressure held only up to the internal sprayer manifold. The storage receiver itself is *fully vented* and operates at constant, safe atmospheric pressure.

This simple but basic difference opens the way to a whole series of better performance characteristics, including:

LOW OPERATING COSTS
LOW MAINTENANCE COSTS
COMPLETE OXYGEN REMOVAL—(to .005 cc/liter)
COMPLETE SAFETY
WIDE RANGE FOR LOAD VARIATIONS
SIMPLER DESIGN AND OPERATION

The "hows" and "whys" of Schaub Zero-Oxygen Deaerators make an important story for any engineer or operating man concerned with boiler feedwater deaeration. Mail the coupon and we'll send it to you.

FRED H. SCHAUB ENGINEERING COMPANY
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MAIL THE COUPON FOR BULLETIN 575

Why a deaerating system? How can it save you money and trouble? What makes a good system? How to get maximum benefits at lowest cost? What are some of the engineering factors involved?

These and many other questions are answered in Schaub Bulletin 575, just off the press. It's a valuable contribution to boiler deaeration theory and practice.

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Please send me, without cost or obligation, my personal copy of your new Bulletin 575 on Boiler Feedwater Deaeration.

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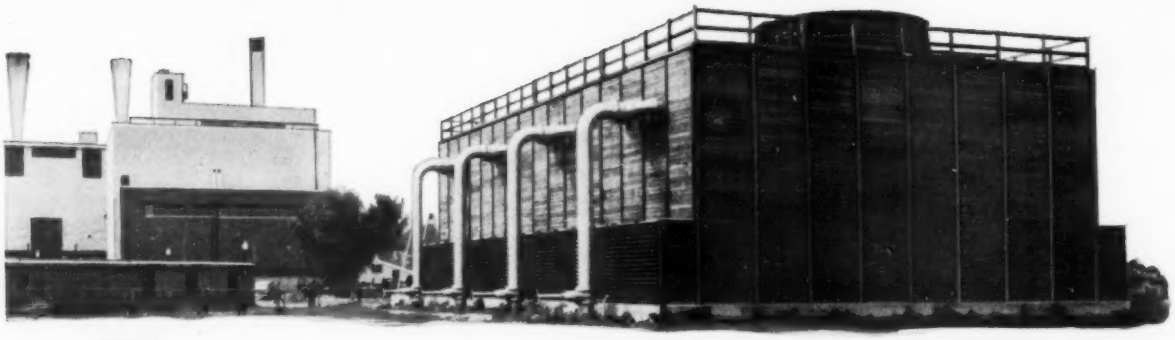

MODERN PLANTS NEED PRITCHARD!

The Pritchard Heavy Duty Cooling Tower pictured here was designed and constructed for the St. Joseph Light & Power Co., St. Joseph, Missouri. This mechanical draft tower has the capacity to cool water from 115° F down to 95° F at the rate of 21,400 gallons per minute. The amount of water conserved for re-use by this Pritchard tower amounts to about *twice* the total rate of water consumption for the entire city of St. Joseph.

Such dependable performance and vital water conservation is Pritchard's answer to industry's demand for modern, efficient cooling tower operation. Pritchard's long experience and constant research produce towers that are designed *right* . . . engineered with adequate capacity . . . to do any required cooling job. Exclusive design features and rugged long-life construction assure top value . . . both in first cost *and* operating costs.

Farsighted industrial leaders—like the officials of the St. Joseph Light & Power Company—are giving top priority to modernization plans for conserving water and improving plant efficiency. That goal is the reason so many of these men depend on Pritchard—a founder member of the Cooling Tower Institute. They know that whether modernizing or expanding they can depend on the *guaranteed performance* of a Pritchard Heavy Duty Cooling Tower.

Whatever your cooling tower need, solve it easily by contacting your nearest Pritchard representative listed in the classified section of your telephone directory or write direct to Pritchard's General Offices, Kansas City, Mo.

Pritchard QUINTAIR* Air-Cooled Heat Exchangers

This quality Pritchard unit guarantees modern cooling efficiency . . . provides low-cost, dependable cooling of engine jacket water or lubricating oil; condensing and cooling of hydrocarbons and steam; money-saving operation in other process cooling service. A single unit may be used for two or more simultaneous cooling jobs. Long, trouble-free service is assured by quality Pritchard construction. Practical Pritchard design makes all parts that may require attention readily accessible for quick, easy inspection and maintenance. Completely fabricated . . . shipped ready for fast, easy installation.

*Registered Trade Name

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Cooling Towers
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Gas and Air Treating Equipment
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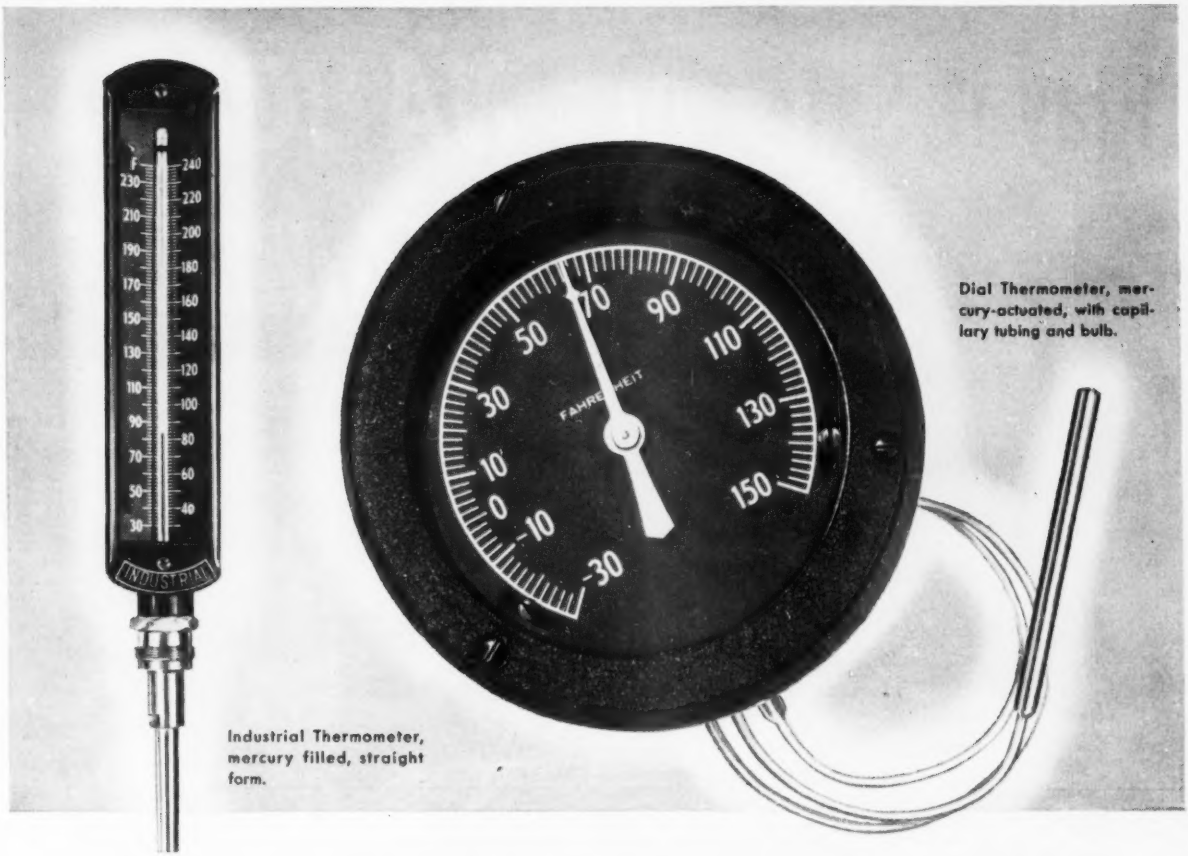
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Dial Thermometer, mercury-actuated, with capillary tubing and bulb.
Industrial Thermometer, mercury filled, straight form.

HAVE YOU AN INDUSTRIAL TEMPERATURE TO TAKE?

Whenever an industrial temperature has to be taken there is a USG thermometer for the job. You have your choice of the Industrial Type in all sizes, and mounting forms with standard or protected stems; or the Dial Type in a variety of sizes, case styles, mountings, ranges, and connections. Gas, mercury or vapor-actuated.

For typical applications of commercial and approved Navy Standards, covering dimensional information and the use of bushings, flanges, sockets and special tubing, send for Catalogs 100 and 200.

Special thermometers for dough testing, milk testing, fuel gas, candy, solder baths, varnish, canning, vulcanizing and other unusual processes.

Industrial Thermometer of the 45° Recline Form. There are 5 other standard forms.

Dial Thermometer with bottom-connected rigid stem, one of many USG types available.

UNITED STATES GAUGE

United States Gauge
Division of American Machine and Metals, Inc.
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Gentlemen: We are interested in USG ☐ Industrial Thermometers; ☐ Dial Thermometers. ☐ Please send us your catalog. ☐ Have your man call. No obligation, of course.

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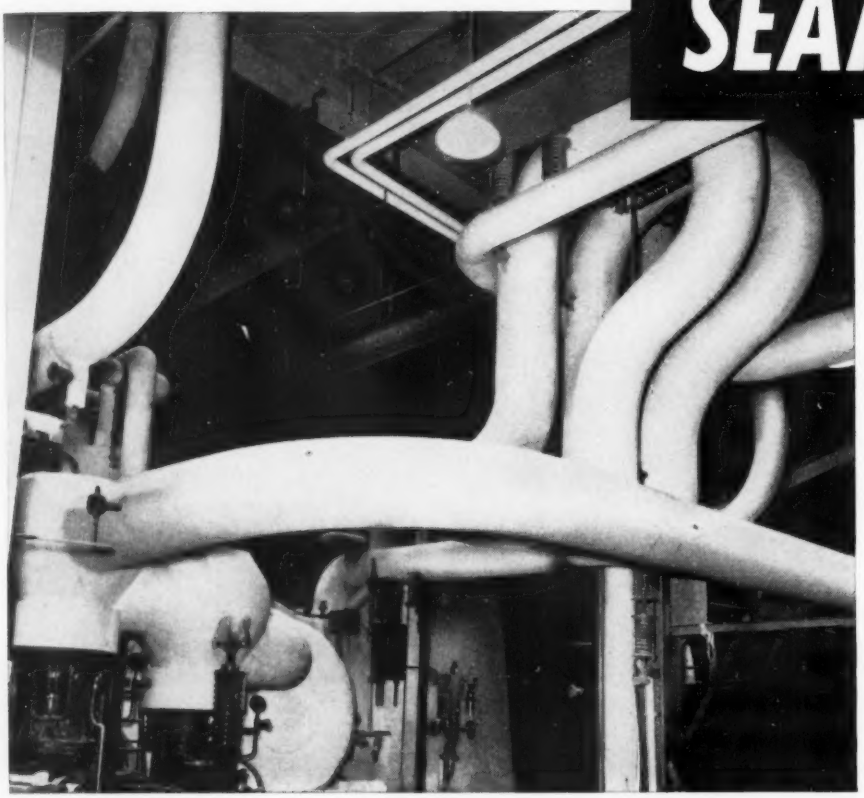
Play it Safe with NATIONAL SEAMLESS



● With pressures and temperatures constantly increasing, plant engineers everywhere are putting their complete confidence in U·S·S NATIONAL Seamless Pipe and Tubes. And for good reason. The life of a modern steam plant hinges on the dependability of its high pressure steam lines. And there is no more dependable power piping than NATIONAL Seamless —the famous "Walls Without Welds" that give you the extra margin of safety that only Seamless provides.

U·S·S NATIONAL Seamless has never been surpassed for power plant service, even under the severest operating conditions. Pierced from solid billets of steel, NATIONAL Seamless Pipe and Tubes have the strength, uniformity, and dependability of solid forgings. Each length is an homogeneous steel cylinder with uniform wall strength throughout. NATIONAL Seamless is designed to remain structurally sound under high temperatures and intense pressures.

If you're planning the building of a new plant or repiping a present installation, remember to "play it safe" and specify NATIONAL Seamless Pipe and Tubes for longer, safer, more dependable, more economical service.

Further information about NATIONAL Seamless Pipe and Tubes for power plants is offered in the following free booklets:

Bulletin Number 26 — concerns the properties of steels employed for elevated temperatures.

Bulletin Number 10 — technical data on high-pressure power plant piping.

Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.

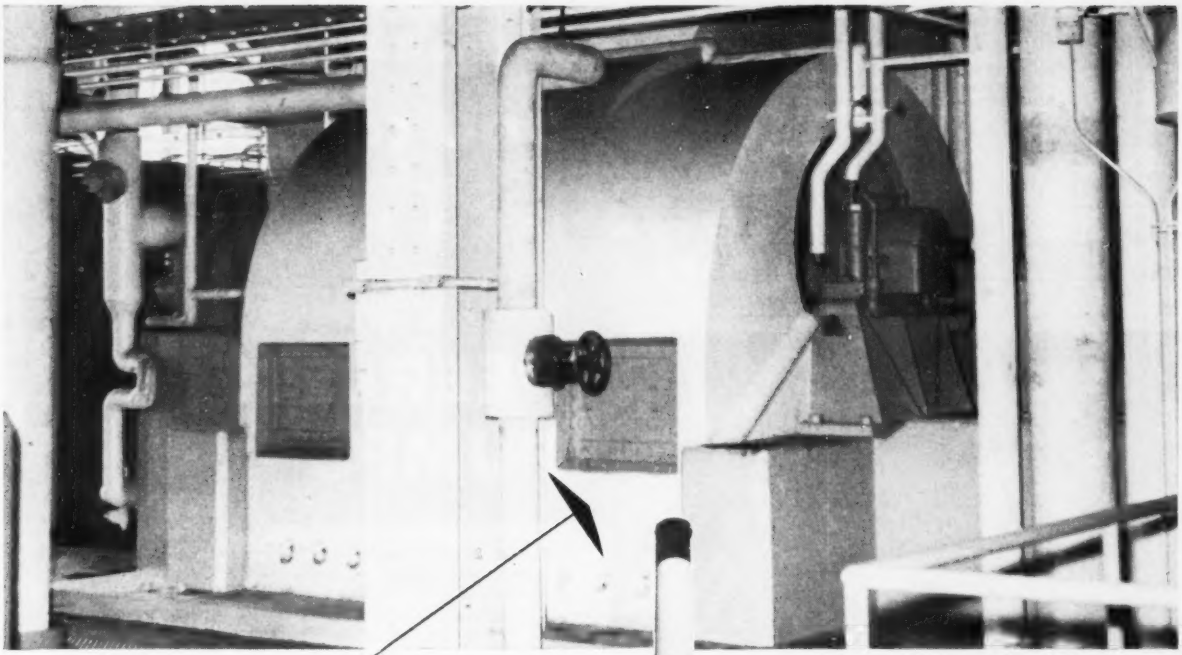
(Tubing Specialties)

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S NATIONAL Seamless PIPE AND TUBES

USS

UNITED STATES STEEL



ANOTHER PLANT INSURES ITS INDUCED DRAFT PERFORMANCE

More carefully constructed from materials more enduring...you can RELY on Clarage Type RT Induced Draft Fans for economical, round-the-clock service—despite high temperatures, high pressures, high operating speeds. Nothing finer in fan equipment is available for those who want the very best.

CLARAGE FAN COMPANY • KALAMAZOO, MICH.

Holland's Municipal Power Plant Installs Clarage Type RT Fan Equipment

This No. 16, Type RT Induced Draft Fan, shown above, handles 77,700 c.f.m. of flue gases at 410°F., and 11.4 static pressure—operating speed 850 r.p.m. Note water cooled bearing, and opening panels in fan housing for easy access to fan interior.

Write for This Catalog!

All Type RT Fan features are pictured and described in this Catalog 901 which also includes valuable engineering data. Write us for your free copy today.

James De Young Generating Station, Holland, Michigan

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☐ FIRE PROTECTION PUMPS BULLETIN B-1500 BULLETIN B-152 ☐ TYPE PR REFINERY PUMP BULLETIN B-1605 ☐ MIXED FLOW PUMPS BULLETIN B-148

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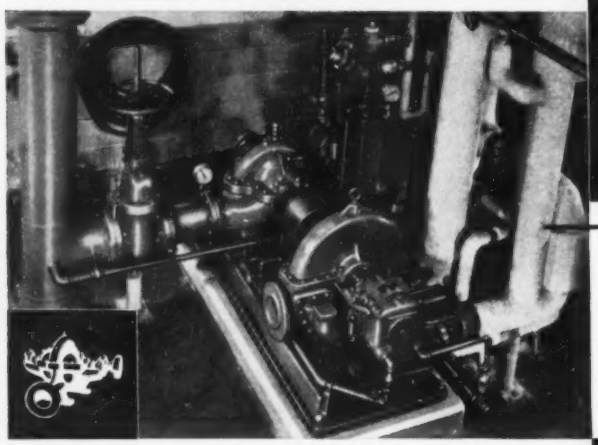
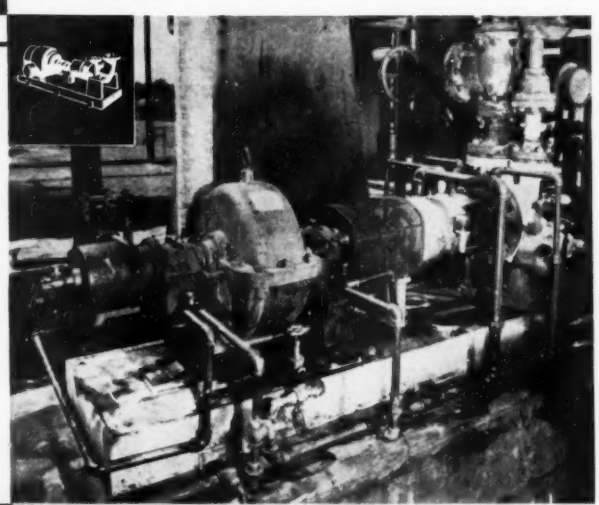
You can do a BETTER JOB with *Dependable* PEERLESS PUMPS

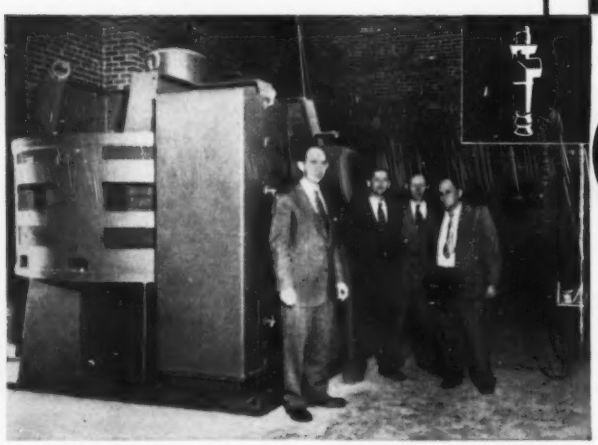


FIRE PROTECTION PUMPS—*A Peerless fire pump provides permanent and reliable fire protection for every commercial and industrial risk.* Peerless, with fully approved fire protection pumps, approved fire protection pump auxiliary equipment, and skilled fire protection pump application service offers unsurpassed protection against the hazards of fire. At the left is a typical Underwriters' approved Type AF Peerless horizontal fire pump, equipped with steam turbine drive. Widest range of approved ratings are available. Described in Bulletins B-1500 and B-152.

HEAVY DUTY CENTER-LINE MOUNT PUMPS—*The continuous transfer of crude charge stocks at high temperatures is handled by type PR pumps.* The Peerless line of packing gland construction and mechanical shaft seal construction pumps for handling hydrocarbons, chemical solutions and water at elevated temperatures and pressures is most complete. The pump in the view at the right is handling oil at 850° F. in an Oklahoma refinery. These refinery and chemical process pumps have a number of modern design features to recommend their installation. Fully described in Bulletin B-1605.



VERTICAL FLOOD CONTROL PUMPS—*Peerless mixed flow and propeller type pumps are widely applied to both industrial and public works large volume pumping.* These are the giants in the world of pumps. The pump shown below is one of a score of Peerless mixed flood pumps installed in flood control pumping stations along the Ohio River for the Corps of Engineers. Capacities as high as 220,000 gpm can be handled. Widely used by industry for such applications as pumping sea or river water for steam generation stations, process service work in chemical plants, waste disposal and a wide range of similar applications where liquids must be transferred in large volumes against low heads. Fully described in Bulletin B-148.



PEERLESS PUMPS

fmc

PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION

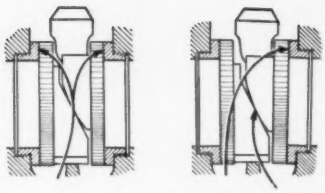
Factories: Los Angeles, Calif. and Indianapolis, Indiana.
Offices: New York; Atlanta; Chicago; St. Louis; Indianapolis; Phoenix; Fresno; Los Angeles; Tulsa; Dallas; Plainview; and Lubbock, Texas; Albuquerque, New Mexico.
Distributors in Principal Cities; Consult your Telephone Directory.

2 WAYS TO GET BETTER VALVE SERVICE!

1 ...UNIQUE DARLING DOUBLE REVOLVING DISC, CAST STEEL GATE VALVE

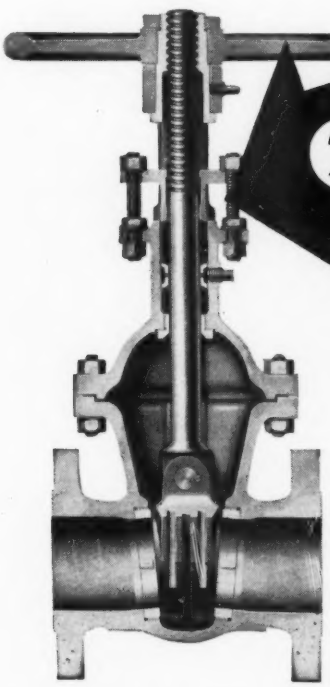
YES, here's a sure way to get better, more dependable valve service. Install this Darling gate valve of the fully revolving double disc, parallel seat type. Time after time users rate it number one for the elimination of down-time and repeated maintenance headaches.

Check the diagrams at right. Note how this Darling gate valve automatically compensates for body distortion, and resulting misalignment of seats. The upper wedge face is radiused, while the lower wedge face is straight, thus disc-to-seat pressure is equalized, assuring tight closure despite distortion and wear.



Discs and seats are parallel. *Seats forced out of parallel by body distortion but discs adapt themselves to give positive closure.* *Radiused face of wedge allows discs to adjust tightly against both seats.*

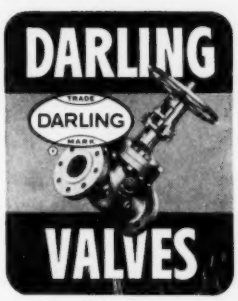
For foolproof simplicity in maintenance and reassembly, and unequalled service life, install this superior Darling Cast Steel Gate Valve.



2 ...DARLING SLOTTED WEDGE CAST STEEL GATE VALVE

HERE'S the second good way to get better valve service. This Darling gate valve's slotted wedge provides *flexibility* when it's needed! It automatically compensates for expansion and contraction due to temperature changes, avoids leaks and minimizes wear and tear on the wedge faces and seats.

What's more, the wedge has *double* guide grooves which engage twin ribs in the valve body. This provides twice the usual bearing area, assuring smooth trouble-free alignment every time!



FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

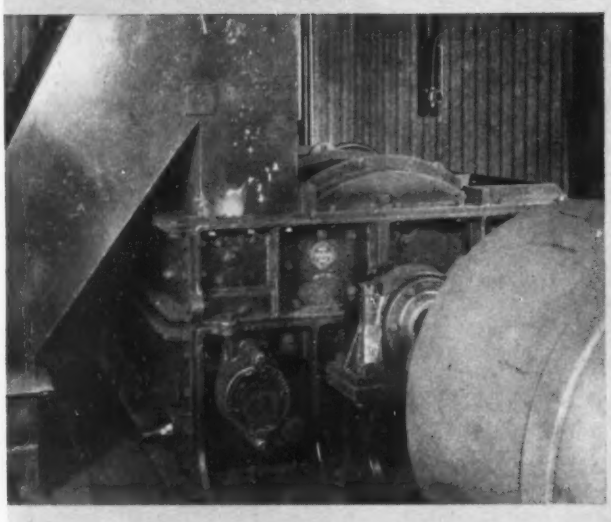
EVERY NEED. *Darling gate valves are made in a wide range of sizes, types and constructions for all kinds of normal and unusual service . . . and for pressures up to 1500 pounds.*

DARLING VALVE & MANUFACTURING CO.

Williamsport 8, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

Check *American* Quality—Feature by Feature—and you'll know



DESIGNED FOR REDUCING ROM LIGNITE to ¾" product. User reports this American AC-3-C Rolling Ring Crusher reduced over 200,000 tons—without a single repair or replacement!

WHY AMERICAN CRUSHERS can reduce coal for less than

per ton

AMERICAN Feature No. 5

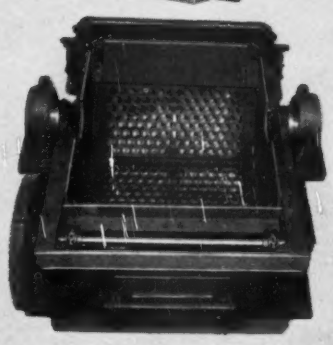
EVERY *American Crusher* IS... CUSTOM-BUILT TO MATCH A NEED

Mass production, in its usual meaning, does not exist in the American Pulverizer factory. *Every crusher is custom built* to perform according to your specific needs: the type of coal, size of feed, ROM or lump, reduction to be made, percentage of fines, tonnage per hour—all are important considerations translated into the design of each American Crusher.

To build a crusher exactly suited to your needs, American has developed many different crusher types—each available in a number of sizes, and each custom-designed to give you the proper crushing elements, screen plates and grate bars to provide correctly sized reduction in the quantity desired.

Performances in hundreds of mines, power plants and central stations conclusively prove Americans will crush coal for *less than 1¢ per ton* including depreciation, replacement parts, power and interest on original investment.

WRITE for Complete Literature.
Sales Representatives in Principal Cities.



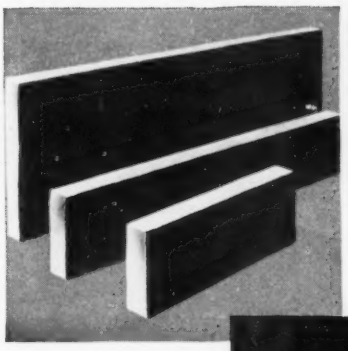
American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • SAINT LOUIS 10, MO.

EAGLE-PICHER

Supertemp P-V Blocks



NEW STRENGTH AND LIGHT WEIGHT

for temperatures from

100 F. to 1900 F.

New light weight! Supertemp P-V Blocks are easily handled without breaking.

New strength of Supertemp P-V Blocks comes from a completely new manufacturing process developed by Eagle-Picher's research and engineering departments.

New light weight of Supertemp P-V Blocks results from the millions of "dead" air cells in Eagle-Picher's High Temperature Mineral Wool.

New strength plus extremely high thermal efficiency! Supertemp P-V Blocks are designed for continuous temperatures up to 1900 F. They're chemically and physically stable, too . . . ideal for heavy-duty insulating service.

New light weight makes P-V Blocks easy to handle—easy to apply—easy to cut for perfect fit. No special tools required.

And, of course, like all other Eagle-Picher insulation, Supertemp P-V Blocks soon pay for themselves in fuel savings and improved temperature control.

EAGLE-PICHER INSULSEAL PROTECTS! *Any insulation worth applying is worth protecting—and Insulseal provides a coating for insulation that dries to a flexible, hard, durable surface.*

Since 1843

EAGLE EP PICHER

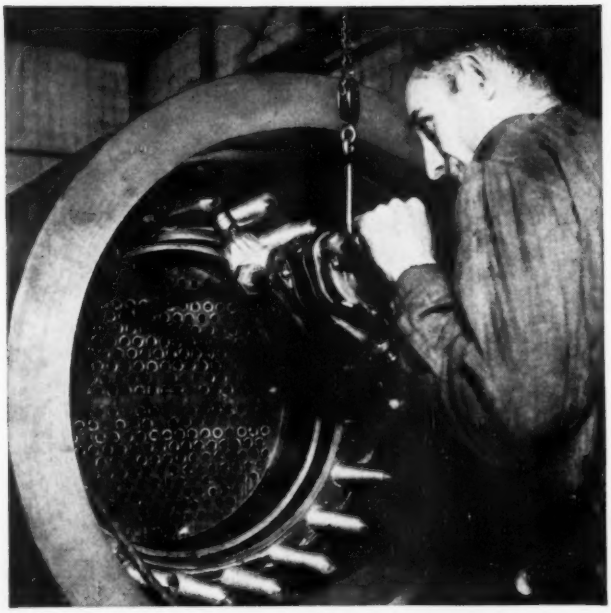
THE EAGLE-PICHER COMPANY

General Offices: Cincinnati (1), Ohio

Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.

Member of Industrial Mineral Fiber Institute

When you need a good general-purpose alloy —try Monel!



Expanding Monel tube into the head of a high-pressure feed-water heater. Here's an example of where Monel's high ductility combines with its other characteristics to make it the perfect metal for the application.

Today, even the most "up-to-the-minute" metallurgist finds it hard to keep pace with all the alloys and their many applications.

But, in the power field, there is one general-purpose alloy with sufficient all-round usefulness to solve a number of metal selection problems – pump shafts, impellers, valve seats and stems, to name a few.

That alloy is Monel®!

Monel is a solid solution alloy with good strength (twice that of brass and equal to structural steel). And it retains its strength at operating temperatures of 700-800° F.

It has good resistance to corrosion, cavitation and erosion. And its high ductility provides good workability. It is supplied in all general mill forms as well as in castings.

You can get some idea of how useful Monel can be when you consider just one application —high-pressure feed-water heater tubes—where it proves to be the *only* answer.

Here's a job that calls for a strong, corrosion-resisting metal with good heat transfer properties and high resistance to erosion and cavitation. In addition, the metal must be capable of standing operating pressures up to 3,000 pounds per square inch and even higher.

Monel meets *all* these requirements!

There are all kinds of applications in which this versatile alloy can be helpful. For more information on its characteristics and uses, write for Technical Bulletin T-5, "Engineering Properties of Monel and 'R' Monel."

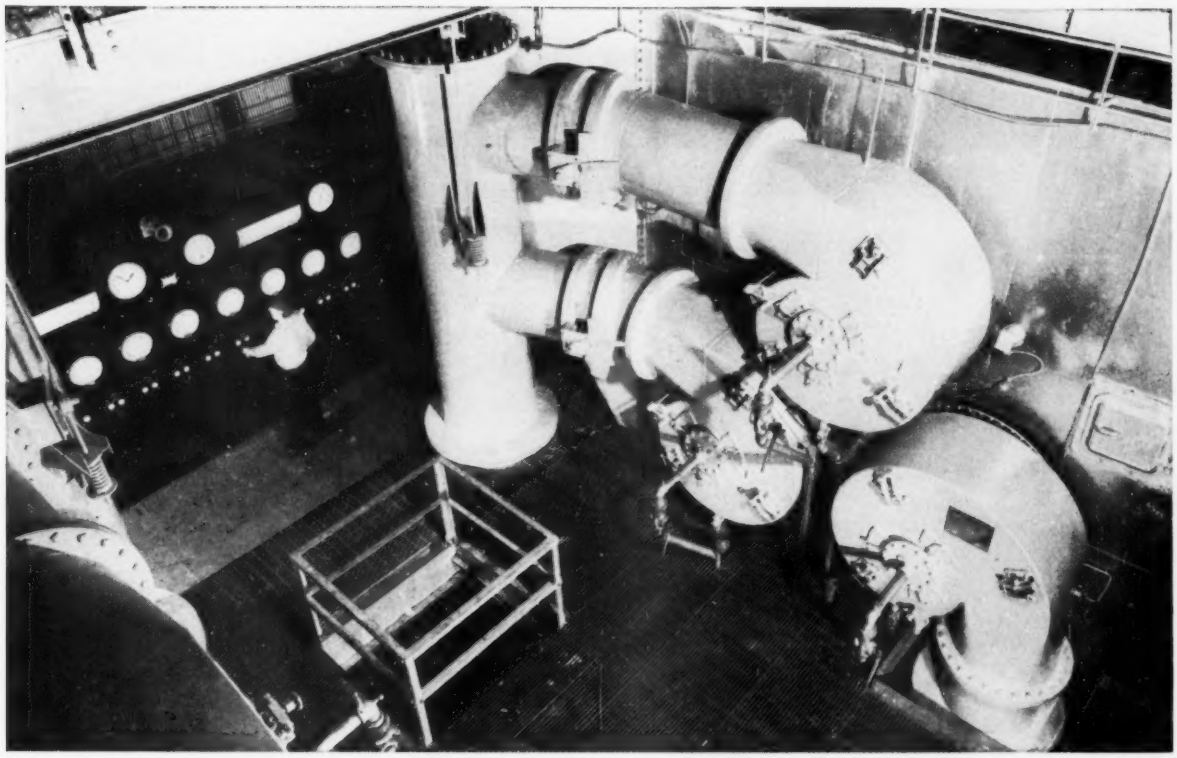
It is advisable to place equipment orders with your suppliers well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply the latest information on availability from warehouse and mill.

The International Nickel Company, Inc.

67 Wall Street, New York 5, N. Y.

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL
"KR"® MONEL • "S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL® • INCONEL®
INCONEL "X"® • INCONEL "W"® • INCOLOY® • NIMONIC® ALLOYS



ANOTHER DRAVO-BUILT J&L BOILER PLANT

A good example of how Dravo Corporation serves as a complete "Construction Department" for industry is the story behind the erection of a new boiler plant at Jones & Laughlin Steel Corporation's Cleveland Works.

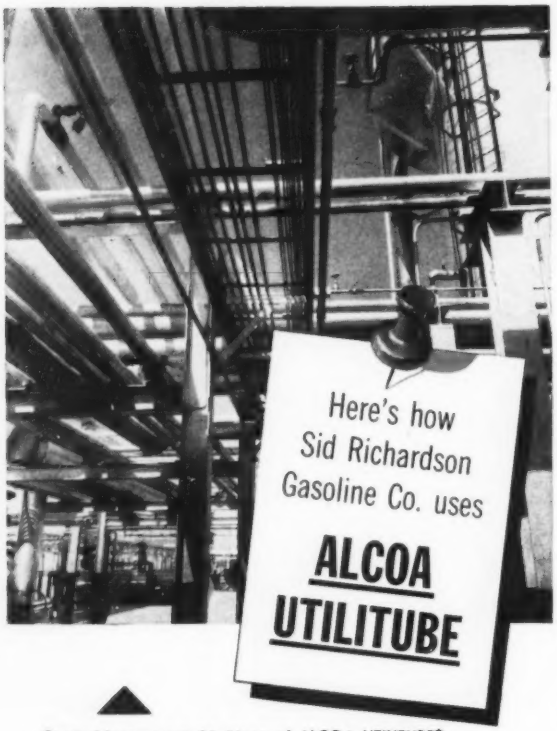
Dravo handled the entire job on a "turn-key" basis. In this capacity, Dravo furnished the materials, erected the building, installed the boilers and auxiliary equipment, fabricated the pipe at its Marietta Plant, erected it, and supplied the Tri-Lok Open Steel Flooring. The completed plant was turned over to J&L . . . ready for operation.

Dravo has often performed in this manner for utilities and industry, delivering to the customer a completed power station, boiler plant, water-pumping station, pipeline facility, water or waste treatment plant. Many customers have taken advantage of Dravo's 60 years of experience in all types of engineering construction and have benefited through the savings made possible by Dravo's single-contract responsibility.

Why not find out today how Dravo can be of service to you? Write or call the Construction Department, Dravo Corporation, Fifth and Liberty Avenues, Pittsburgh 22, Pennsylvania.

THIS *too* IS DRAVO

Air conditioning • boiler and power plants • bridge sub-structures • compressor and pumping stations • crane cab coolers • docks, locks and dams • dredging • gantry and floating cranes • industrial foundations • marine repairs • open steel flooring • ore and coal bridges and unloaders • pipe prefabrication and erection • pump houses and intakes • ready-mixed concrete • river sand and gravel • river transportation • slopes, shafts and tunnels • space heaters • steel shipping containers • towboats and barges • water and waste treatment plants • DRAVO



Control-Instrument Air Lines of ALCOA UTILITUBE* at Keystone Plant, Kermit, Texas. Exposed to hydrogen sulfide fumes since installation in 1948, aluminum tubing and fittings have required no maintenance, show no apparent corrosion. Air, dried by Alcoa *Activated** Alumina, operates at 80° F and 25 psig.

ALCOA UTILITUBE is aluminum coiled tube made of a specially selected alloy to provide low cost, easy workability and high fatigue strength.

ALCOA Utilitube offers savings up to 40 per cent over copper . . . has excellent on-the-job forming and flaring properties. It is available in economical, long lengths up to 1,000 feet or more, depending on size. It stands up well under vibration . . . has high resistance to most industrial atmospheres and to many liquids and gases.

In petroleum service, ALCOA Utilitube will not form sludge or gum . . . will not discolor or contaminate the fluid it carries.

ALCOA Utilitube is versatile. Use it for air for pneumatic and hydraulic control circuits and brake lines—gasoline and fuel oil for internal combustion engines—lubricating oils for engines and machines—fluids for hydraulic systems.

For complete details, write for the new booklet: "Alcoa Utilitube."

ALUMINUM COMPANY OF AMERICA
1004-K Alcoa Building, Pittsburgh 19, Pa.

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Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

This message from

Power

appeared recently
in Business Week
to remind management men
throughout iudustry
of the vast scope
and key importance of power
and of the men
who direct
the power services

ONE CONTROL DOES THE JOB OF TWO

DA-400

Available with Explosion-Proof or Weatherproof Housing

Mercoid DA-400 Series Pressure Controls incorporate a single bourdon tube which actuates two independently adjustable Mercoid magnet operated mercury switches to accomplish various circuit operations. For example:

1. Close one alarm circuit at high pressure and another at low pressure with both circuits open over operating range.
2. As an electrical interlock to open one circuit as pressure rises above and the second circuit as the pressure drops below operating range.
3. To provide two-stage control by opening or closing one circuit on a rise in pressure and the second circuit on a further rise in pressure.

Equipped with calibrated dial and outside adjustments—Ranges 0-30 psi to 300-2500 psi—The Mercoid magnet operated mercury switches are not affected by harmful effects of dust, dirt, or corrosion—your assurance of millions of operations.

Write for Bulletin 5P

THE MERCOID CORPORATION
4201 BELMONT AVE., CHICAGO 41, ILLINOIS, U.S.A.

"The gap is closing up between cost and income. As competition gets sharper, management men are trying hard to find new corners to cut. Trouble is, the biggest part of the cost of most products is wages. And everybody knows you can't cut wages."

Who says you can't cut wages?

In most of the talk about profits these days you usually hear something like the quote above.

Well, pardon the expression, but everybody is just plain wrong.

What everybody is overlooking is that there are *two kinds* of wages in the manufacture of any product you can name. One of them has been coming down ever since Franklin flew his kite.

You've got a wage bill for the manpower that goes home every night. And you've got another wage bill for the horsepower that's always there . . . at the end of a throttle or behind a toggle switch or on the rim of a V-belt.

Are you doing all you can to cut the wages of those horses?

Or, are you trying to produce a modern product and perform a modern service with an antique power plant?

If your company is typical, in the last 15 years you've given each of your workers an extra 2 horsepower to work with. You've increased (by 30%) the effective muscle of every man you employ. But this makes it all the more important that your horses are the modern low-cost kind. You probably can reduce their feed bill if you try.

You may not be aware of the seven-league strides in efficiency made by the manufacturers of power equipment in recent years. But the editors of POWER magazine are. And, via the pages of POWER, the chances are your power engineer is.

He's the fellow, by whatever title management knows him, who buys and curries those horses and delivers them in so many forms* to your production staff.

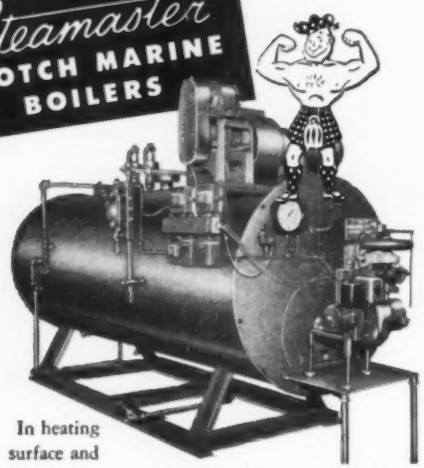
Have you talked to him lately about cutting part of your wage bill?

One of America's primary industrial media and a member of the Audit Bureau of Circulations

McGRAW-HILL . . . ABP

*electricity, steam, conditioned air, water, mechanical power.

Steamaster
SCOTCH MARINE BOILERS



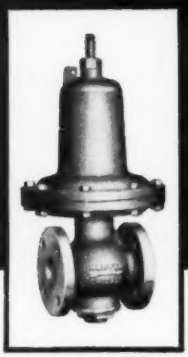
In heating surface and service, you get more for your money... an exceptional 7 to 8 sq. ft. heating surface per boiler hp.

- Ten sizes from 3 to 150 hp
- Passes any insurance inspection
- No lagging or brickwork
- Gas, oil or combination firing
- Natural or induced draft
- Multi-pass design saves fuel
- Submerged tubes last longer

Write, wire or phone today for a personal survey of your boiler needs.

STEAMASTER AUTOMATIC BOILER CO.
5819 Compton Ave., Los Angeles 11, California • LUcas 6226

REDUCING VALVES



No. 700 illustrated — Water pressure reducing 300 lb. initial to 50 lbs. delivery. Spring-diaphragm type for noiseless, dead end service. Large flow passages. Tight closing. Designed for maintenance without removal from line. Compact. Dependable. Other types available. GET BULLETIN 148.

Call Your Supply House or See Classified Phone Directories for Nearest KLIPFEL Distributor.

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K-941

Klipfel VALVES, INC.
HAMILTON, OHIO

WANT *Economy* AND *Efficiency* IN YOUR BATTERY-CHARGING OPERATION? . . .

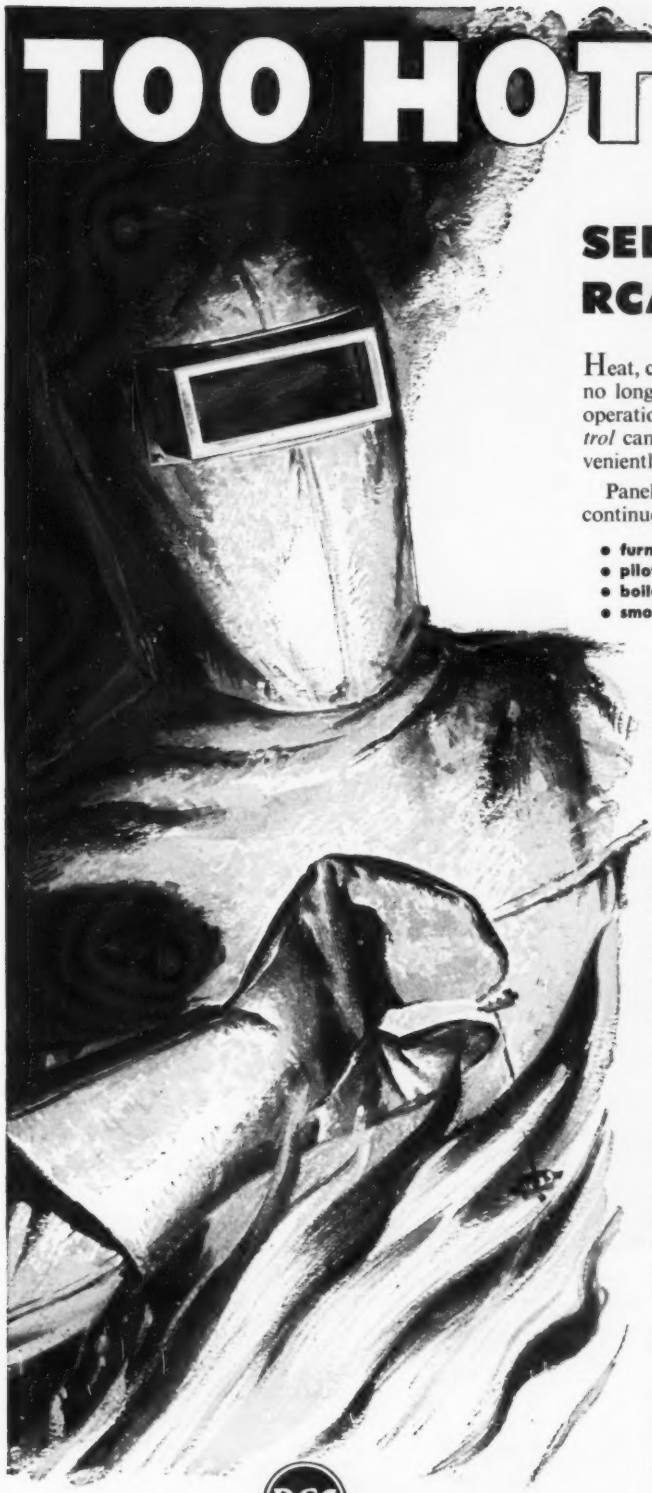
INET INC.
PROVIDES BOTH WITH
STABILIZED RECTIFIERS

Compact, safe, completely self-contained D.C. power supply in mobile, floor-standing or wall types. Units incorporate voltage stabilizing transformers and selenium rectifiers. Low first cost . . . low maintenance. Rated capacities 3 to 60 cells, 4 to 12 Amps. Highly efficient Stabilized Battery Chargers.

Complete engineering specifications available upon request.

INET INC.
8655 South Main Street, Los Angeles 3, California

TOO HOT *to approach?*



SEE IT CLOSE-UP WITH RCA INDUSTRIAL TV

Heat, cold, danger or inaccessibility need no longer hamper supervision of remote operations. Constant watch and *close control* can be maintained—safely and conveniently—with RCA Industrial TV.

Panel-mounted ITV monitors permit continuous observation of:

- **furnace combustion**
- **pilot burner operation**
- **boiler water levels**
- **smoke stack discharge**

Rugged Vidicon Tube shrinks camera size

RCA's Vidicon camera tube cuts the weight of the RCA Industrial TV camera to a mere 7½ pounds. It measures 3″ x 5″ x 10″—fits practically anywhere. And, because of the Vidicon's tough, compact construction, your RCA Industrial TV camera can handle heavy-duty jobs of all types.

High-Definition Picture for close control

With RCA Industrial TV, you attain the accuracy of direct observation without danger or inconvenience. Centralized, visual control over a number of remote or inaccessible operations is readily achieved. And, *all* camera adjustments are made at the viewing monitor. Scanning frequencies are 525 lines, 30 fields, 60 frames interlaced—the same as commercial television. With RCA Industrial TV, you see a high-definition, high-contrast picture that's ideal for close control.

Check RCA Industrial TV for workability

Check these important RCA features: 2-unit chain, 110-volt, 60-cycle AC operation—2-knob control for all normal requirements. Investigate the full line of RCA-engineered, field-proven accessories—water-cooled camera lens: shock mounting; automatic iris control; weather- and explosion-proof housings; remote panning; camera switching equipment. RCA Industrial TV can be used in extreme ambient temperatures, indoors or outdoors.

In addition, check RCA's practical Service Plan—complete nation-wide service by the RCA Service Company.

Before specifying, get full details on RCA Industrial TV. FOR INFORMATION MAIL COUPON NOW.

Industrial Products, Dept. 208V
RCA Engineering Products, Camden, N. J.
Please send me information on RCA Industrial TV.

Name_____ Title_____

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RCA

INDUSTRIAL PRODUCTS
RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT CAMDEN, N.J.

In Canada: RCA VICTOR Company, Limited, Montreal

"GUNITING" with *Super* ADACHROME-CAST

Tradename "Guniting" courtesy Cement Gun Co., Allentown, Pa.

...SAVES OUTAGE TIME and MONEY

Use **SUPER ADACHROME-CAST** to gunite your stud tube water walls.—Fine-grained to penetrate the small apertures between studs,—packs to a dense mass when shot. One user reports **SUPER ADACHROME-CAST** lasted twice as long and took but one-third the time to apply as compared with a plastic chrome ore installation.

Excellent for coating brickwork when free of slag.

Yours, *FREE* for the asking . . . an illustrated, detailed Bulletin on *Super* ADACHROME-CAST.

BOTFIELD REFRACTORIES CO.

784 S. Swanson St., Philadelphia 47, Pa.
In Canada, Canadian Botfield Refractories Co., Ltd., 171 Eastern Avenue, Toronto.

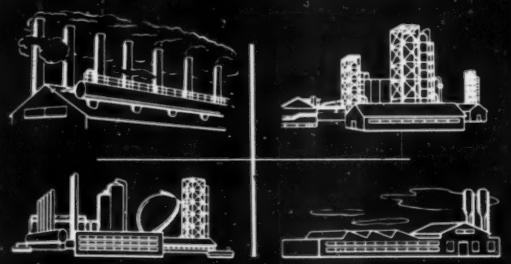
SUPERVISION...

KEY to PRE-FABRICATED PIPING QUALITY

Every step in the fabrication of piping at Western Piping Supply is made under close and continuous supervision. From the day the customer's drawings enter the plant until the completed assemblies leave, this exact control is never compromised. "Watch-dogging" like this always assures WPS customers accurate, trouble-free installations in the field.

WESTERN PIPING SUPPLY DIVISION
THE LUMMUS COMPANY
504 WEST 145TH STREET, EAST CHICAGO, INDIANA
Representatives in Major Cities
FABRICATORS OF CARBON AND ALLOY PIPING

Use
PALMETTO®
Supersheat®
the Universal Sheet Packing for General Industry



Palmetto Supersheat #2900 is the industry-wide choice as an all-service flange and joint sheet packing for super-heated and saturated steam at all pressures and temperatures. Recommended also for air, ammonia, gas, acid, alkali and other applications. Look for the Palmetto trademark!

Gives Basic "3-R"* Performance Maintenance Departments Need

* **It's *Rugged*** — Exceeds Fed. Spec. HH-P-0046. Made of selected long-fibre asbestos pressure-bonded with special heat and chemical resisting bonding materials.

* **It's *Resilient*** — Compensates for expansion and contraction of flanges. Compressible to meet flange surface irregularities.

* **It's *Reliable*** — No variance in performance. Homogeneous construction eliminates ply separation. Heat, chemical and pressure resistant.

OUR 90th YEAR — NEARLY A CENTURY OF *Quality*

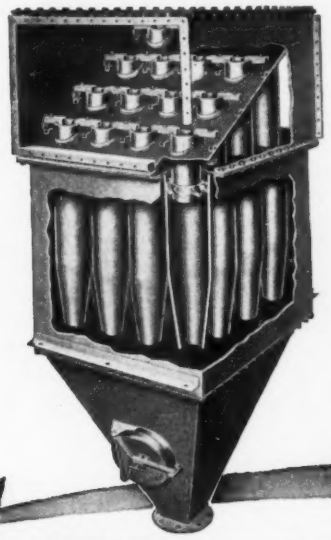
INVESTIGATE! Write for new Bulletin SP-22 to get details on Palmetto Supersheat—and other fine Sheet Packings and Gaskets for *special* conditions.

PALMETTO Packings

packing more performance into every application

GREENE, TWEED & CO. North Wales, Pa.

Before you buy *any* equipment for recovering fly ash . . .



COMPARE ALL OTHERS against MULTICLONE'S Multiple Advantages

Because the advantages of MULTICLONE are so clear-cut, so vitally important, so far-reaching in the savings they make, we urge you to make a factual unbiased comparison of MULTICLONE fly ash collection equipment against *any other* in the mechanical recovery field. Only by making such a comparison can you fully appreciate the major savings and greater performance you get by installing MULTICLONE Collectors!

COMPARE Recovery Efficiency!

It is a recognized fact that the separating efficiency of a cyclonic tube increases as the tube diameter decreases because smaller tubes generate greater centrifugal forces. The patented vane in the MULTICLONE makes the use of small tubes *practical* without complicated manifolding and permits compacting many small tubes into one simple, highly efficient unit. MULTICLONE's higher centrifugal forces throw out not only the large, medium and small particles, but also an unusually high percentage of the *extremely small* particles of 10 microns and less. Result—*more complete recovery of all suspended particles from the gas stream!*

COMPARE Space-Saving Compactness!

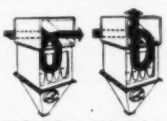
Plant space costs money—particularly at today's high construction costs. Because the MULTICLONE is more compact, size for size, it makes *really important* savings in space and plant costs. Note in the chart how the MULTICLONE requires substantially less space—*both in floor space and cubic space*—than any other unit of comparable capacity and performance. *This means vital savings in construction costs!*

Make	Relative Space Requirements In Sq. Ft.	In Cu. Ft.
Multiclone	1.0	1.0
Collector A	2.1	1.8
Collector B	5.9	3.2
Collector C	6.8	3.9

COMPARE Dollar-Saving Adaptability!

Savings in space is just one of many ways MULTICLONE reduces installation costs. Because the shape of the unit can be readily varied (long and narrow, short and wide, or square) to fit available spaces, the MULTICLONE can often be tucked into odd corners and waste areas too restricted for other equipment.

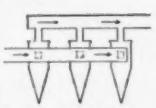
Moreover, inlet-outlet ducts can be varied—side-inlet side-outlet, or side-inlet top-outlet—to meet low headroom or restricted side clearance requirements . . . and the single-inlet single-outlet duct design permits greater flexibility and simpler installation. *These all add up to vital savings in installation costs!*



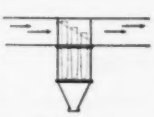
Side inlet, Side outlet **Side inlet, Top outlet**

COMPARE All-Around Simplicity!

The MULTICLONE is simple and inexpensive to maintain because there are no highspeed moving parts to repair or replace . . . no pads or filters to clean or renew . . . nothing to choke the gas flow or increase draft losses as suspended materials are recovered. In addition, the square, flat-sided shape of the MULTICLONE and its straight inlet and outlet ducts are far simpler to install and insulate. And since the recovered material from an entire bank of tubes is collected in a *single* hopper, it is much easier to service and maintain than the multiple hoppers of conventional cyclone units. *Here again, the* MULTICLONE *saves in many ways—all of them important!*



Conventional Cyclone



Multiclone

Whether your recovery installation is in a new structure or for modernizing present equipment, you will be far ahead by installing MULTICLONE Collectors. Our experienced engineers will gladly make helpful suggestions for simplifying your recovery problems. A letter, wire or call to our nearest office places this assistance at your service without obligation.

Send for Helpful Literature! This factual MULTICLONE literature explains the basic principles of cyclonic dust recovery and gives technical data helpful to anyone contemplating a dust or fly ash recovery installation. Write today for your free copy!

WESTERN Precipitation CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: 1049 EST NINTH STREET, LOS ANGELES 15, CALIFORNIA

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PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

ADSCO SEPARATORS INCREASE EFFICIENCY

In Power, Process, or Heating Operations

HORIZONTAL TYPE

VERTICAL TYPE

For high efficiency and low cost, use ADSCO Separators to remove condensate, oil, and minor solids from steam, air, and gas lines. Made in vertical up-flow and down-flow, horizontal, and receiver types. ADSCO Separators are of simple design, have low pressure drops, and are available in a wide range of working pressures and temperatures. Write for Bulletin 46-50B.

AMERICAN DISTRICT STEAM COMPANY, INC.
NORTH TONAWANDA, NEW YORK
Since 1877

Sims

VALVES ARE GUARANTEED to last longer in any pump

HERE'S HOW...

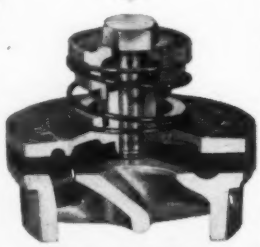
Stem breakage eliminated – by exclusive double shock-absorber stem heads.

Reduced wear - long guide gives even lift. Springs can't jam.

Smooth seating surface– rotating valve disc changes to new seating surface with every pump stroke.

Reduced flow resistance– accomplished by Sims inclined seat-ribs.

Sims Pump Valves, for all reciprocating pumps, are stocked for quick delivery.



Write for Bulletin P-1 explaining how Sims Valves can improve your pump operation at lower cost.

SP-104

SIMS PUMP VALVE CO., INC.
1314 PARK AVENUE, HOBOKEN, N. J.
M&M BLDG., HOUSTON, TEXAS

Here's how El Dorado Refining Company uses ALCOA UTILITUBE

AIR LINES serving instruments at El Dorado Refinery, El Dorado, Kansas. Exposed to typical refinery vapors, 9,000 feet of corrosion-resistant Alcoa Utilitube* were required for this installation. Air, dried by Alcoa *Activated** Alumina, operates at 110° F and 110 psig.

ALCOA UTILITUBE is the lowest cost corrosion-resistant tube you can buy—up to 40 per cent less than other corrosion-resistant metals!

ALCOA UTILITUBE is versatile. Use it for air for pneumatic and hydraulic control circuits and brake lines—gasoline and fuel oil for internal combustion engines—lubricating oils for engines and machines—fluids for hydraulic systems.

ALCOA UTILITUBE stands up well under vibration and also forms and flares easily.

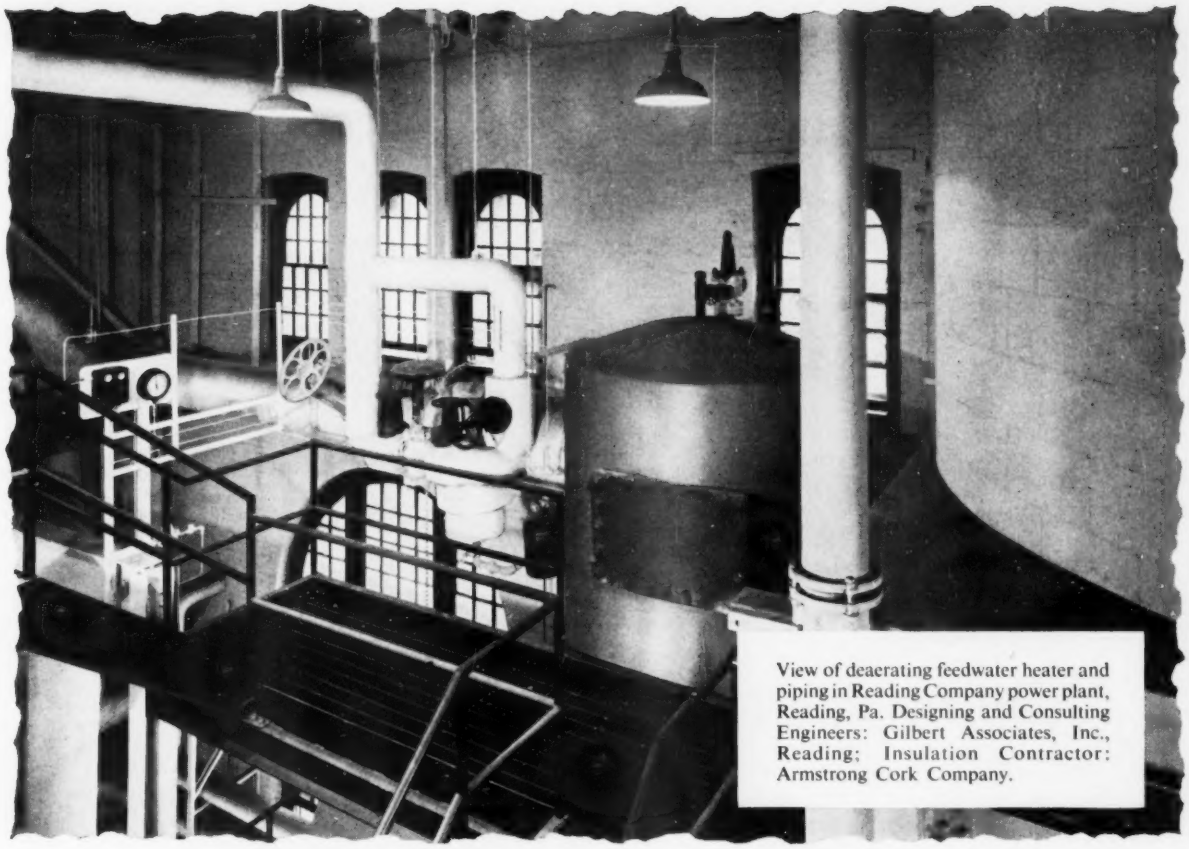
ALCOA UTILITUBE and fittings are available from your aluminum distributor. Look for his name in your classified phone directory. Write for the new booklet: "Alcoa Utilitube."

ALUMINUM COMPANY OF AMERICA
1004-K Alcoa Building, Pittsburgh 19, Pa.

*Registered Trademark, Aluminum Co. of America

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA



View of deaerating feedwater heater and piping in Reading Company power plant, Reading, Pa. Designing and Consulting Engineers: Gilbert Associates, Inc., Reading; Insulation Contractor: Armstrong Cork Company.

"Featherweight" 85% MAGNESIA

USED IN MODERNIZATION OF READING COMPANY POWER PLANT

When the Reading Railroad recently modernized its repair shop power plant, "Featherweight" 85% Magnesia was extensively used. The illustration above shows some of the piping and feedwater heater which was covered with this dependable insulation.

For insulating piping and equipment with temperatures up to 600°F., "Featherweight" 85% Magnesia is unexcelled. It acts as an efficient insulator for a lifetime, too—unaffected by vermin, moisture, vibration, or temperature change. It is made in various shapes and thicknesses for easy application over any equipment or piping.

The K&M distributor in your area is an experienced applicator who will gladly tell you more about "Featherweight" 85% Magnesia. Call him today! Or, write directly to us for information.

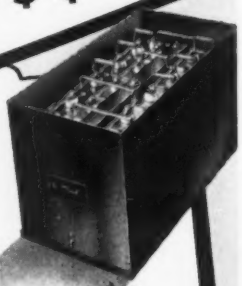
Nature made asbestos...
Keasbey & Mattison has made it serve mankind since 1873

KEASBEY & MATTISON
COMPANY · AMBLER · PENNSYLVANIA
In Canada: Atlas Asbestos Co., Ltd., Montreal, Toronto, Winnipeg, Vancouver

CASE HISTORIES PROVE YOU CAN SAVE $ $ $

with
SPRAGUE POWER FACTOR CAPACITORS

- CUT POWER BILLS
- AVOID EXTRA EQUIPMENT
- ALLOW BIGGER LOADS
- PROVIDE PLANT FLEXIBILITY



Thousands of installations throughout industry are proving daily that Sprague Power Factor Capacitors installed at each piece of inductive electrical equipment eliminate waste current *right at the source.* Power factor is corrected to the maximum, allowing a greater load at reduced power cost. Need for extra wiring, switchgear, and transformers is often avoided, and plant expansion or moves can be made at minimum cost. *Write for Free 28-page Power Factor Correction Guide.*

® SPRAGUE

Industrial Capacitor Div.
SPRAGUE ELECTRIC CO.
357 MARSHALL STREET
NORTH ADAMS, MASS.

Does your practical experience qualify you to sell WATER TREATMENT?

It has in the case of many of our most successful Sales Engineers.

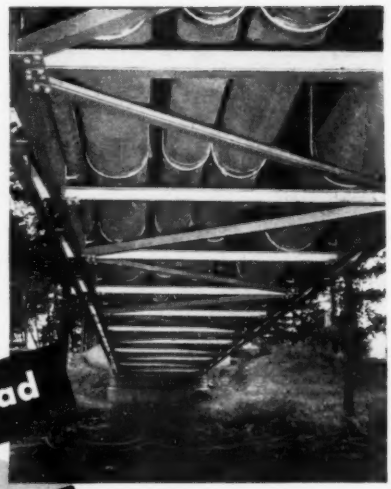
If you have practical boiler room experience, some knowledge of chemistry, an idea you would like to sell, here's an opportunity to better yourself. First you'll be trained, then assigned to an established sales territory (opening created by promotions) with salary, commission and expenses.

Interested? Write or phone Mr. W. H. Bingham for confidential interview.

Dearborn
TRADE MARK

DEARBORN CHEMICAL COMPANY, Merchandise Mart Plaza, Chicago 54, Ill.
Phone: WHitehall 4-3273

Suspended under a bridge these insulated Ric-wiL lines pipe steam to buildings on a large midwestern college campus.



overhead

underground ***Anywhere!***

Ric-wiL units can be jacked through tunnels, under streets or railroad tracks without interrupting traffic.

For Fast Economical installation specify Ric-wiL prefabricated INSULATED Piping Systems.

They are fast, easy and economical to install because they are prefabricated under ideal factory conditions. Less work to be done at job site. Complete technical data and detailed working drawings are provided by Ric-wiL engineering service — more savings in installation time and costs.

Whether your job is underground or overhead — if it calls for proven protection and insulation of steam, hot water, oil or process liquid piping — it will pay you to call in the Ric-wiL representative in your district as early as possible in your planning.

Ric-wiL PREFABRICATED INSULATED PIPING — PIPE CONDUIT SYSTEMS

THE RIC-WIL COMPANY • BARBERTON, OHIO

WHAT MUST YOU HAVE

... IN POWER PIPING?

Above all other things, you must have CONFIDENCE in it.

Confidence can't be purchased—it is acquired only through complete belief in the pipe fabricator's skill, facilities, technical knowledge . . . and *experience.*

P. P. & E. has been fabricating all types of high-pressure, high-temperature piping for central stations, paper mills, process and industrial plants for almost half a century. The importance of this experience, to you, is its great value in avoiding errors of omission and commission which can result in inefficiency, damage to expensive equipment, and dangerous operating conditions.

When P. P. & E. does the job, utmost care is taken to evaluate and interpret specifications correctly, and to comply strictly with code and insurance company requirements. Highly specialized shop facilities for bending, welding, Van Stoning, machining, heat-treating, testing, and inspection have been developed, and are operated by skilled workmen under competent supervision. A trained field organization directs the installation of complete systems, extensions, or alterations to existing layouts in any part of the country.

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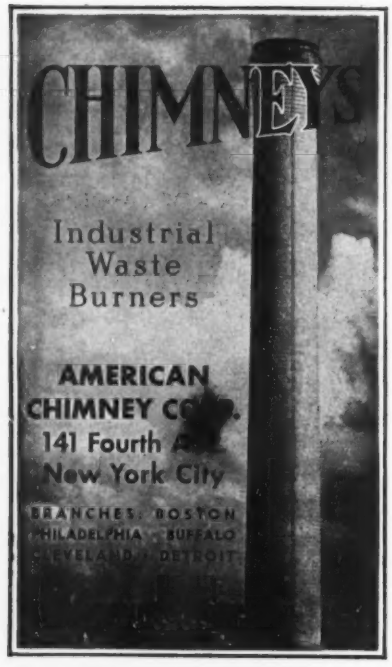
Boston.....10 High Street	New Orleans.....P. O. Box 74
Chicago....Peoples Gas Building	New York...Woolworth Building
Cleveland..Public Square Building	San Francisco..785 Market Street

Pittsburgh Piping
AND EQUIPMENT COMPANY
10 Forty-Third Street—Pittsburgh, Penna.

WHERE TO BUY

Featuring additional products and specialties for power plants.



GAGE GLASSES AND
High Pressure Rubber Gaskets
ALL SIZES TO FIT YOUR GAGES

ERNST WATER COLUMN & GAGE CO.
Send for Catalog LIVINGSTON, N. J.

NEW TUBULAR SCAFFOLD
GOES UP and DISMANTLES EASIER FASTER — STORES COMPACTLY
Completely flexibility as to size and shape. Can be fabricated to fit your needs—rolling, dolly, fixed, chain hoist, etc.
HARDIE CLAMP SCAFFOLDING
519 Atlantic Ave., Brooklyn 17, N. Y.

STOP *that* WATER
With FORMULA NO. 640, a clear liquid which penetrates 1" plus in concrete, brick, stucco, plaster, etc. Seals out water, dirt. Holds 20' head. Use outside and in. Preserves all absorbent materials. Sold 14 years. Quick, economical, sure. $3 in 55's. Free sample. See Sweet's.
HAYNES PRODUCTS CO., OMAHA 3, NEBR.

TO manufacturers of equipment and those offering special services to the power industry, this section offers an inexpensive means of keeping products or services regularly before your potential customers — the readers of POWER. The small spaces available here provide opportunity for you to be represented in every issue at low cost. Can we serve you?

Classified Advertising
POWER

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Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction, Investigations, Valuation and Rates
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Consulting and Designing Engineers
Kansas City, Mo. P. O. Box 7088
Cleveland, Ohio 1404 E. 9th St.

GILBERT ASSOCIATES, INC.
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Engineers
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Procurement — Field Engineering
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THE KULJIAN CORPORATION
Engineers - Constructors - Consultants
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Engineering and Architectural Consultants and Designers
First National Bank Bldg.
Pittsburgh 22, Pennsylvania
Cable Address—"LOFTUS Pittsburgh"

LUTZ AND MAY
Consulting Engineers
STEAM, GAS & DIESEL POWER STATIONS
PUMPING PLANTS—ELECTRIC SYSTEMS
REPORTS—DESIGN—APPRAISALS
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PEARSON and GUSSOW
Consulting Engineers
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PIONEER SERVICE & ENGINEERING CO.
Consulting and Design Engineers
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Engineers
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Design — Reports
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STANLEY ENGINEERING COMPANY
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Design — Construction — Test — Valuation
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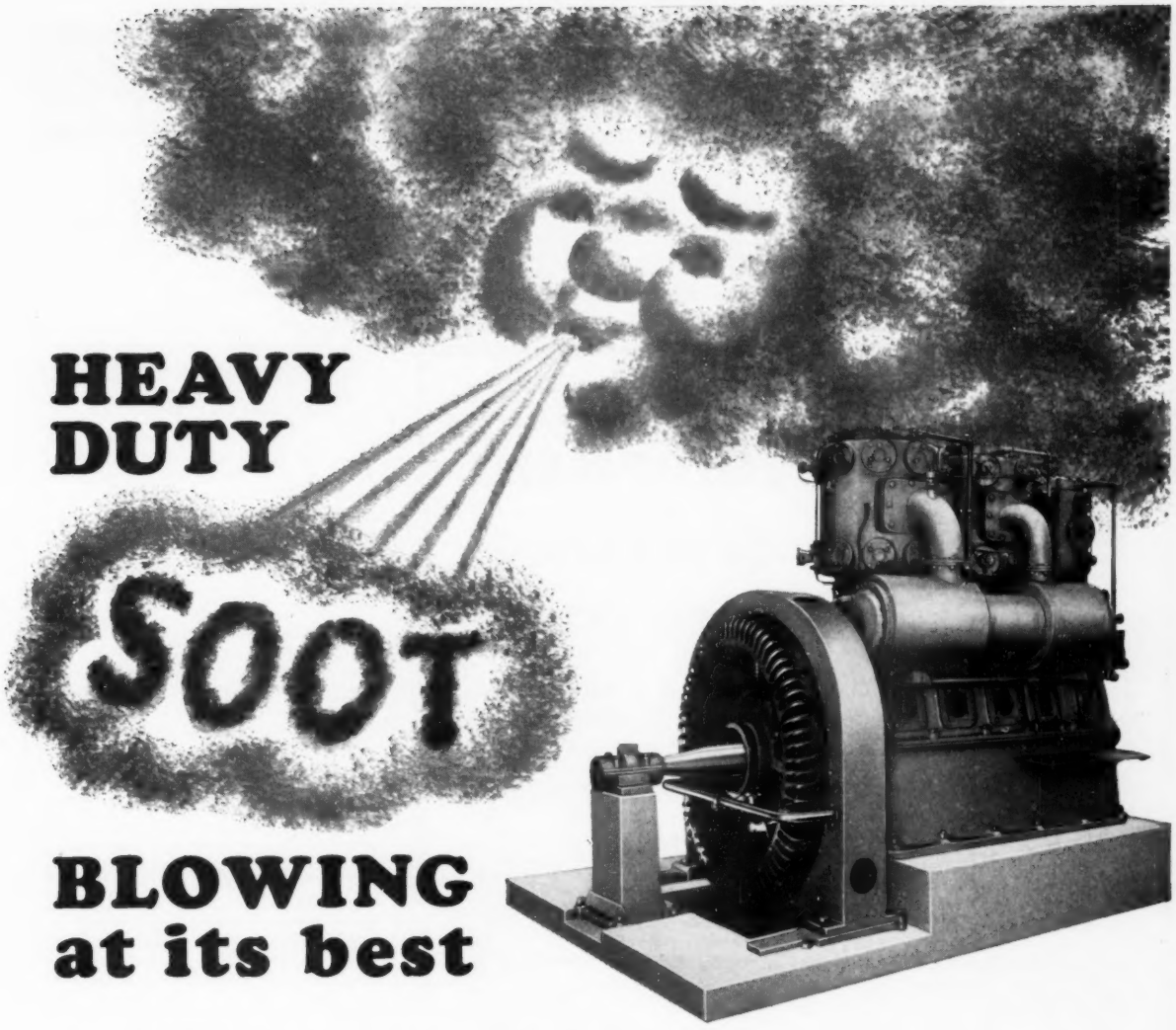
WATER SERVICE LABORATORIES, INC.
Specializing Since 1927
Water Treatment for corrosion control in buildings, boilers and air conditioning systems.
New York—Philadelphia—Washington, D. C.

THE J. G. WHITE ENGINEERING CORPORATION
Design-Construction-Reports-Appraisals
80 Broad Street, New York 4

Consult these SPECIALISTS
Let them save your time by bringing their broad experience in their specialty to bear on your problems.



BLOWING at its best

The Class VCE-3, Three Stage, High Pressure Compressor is ideal for heavy-duty blowing cycles. Simple, well balanced design is afforded by vertical, in-line cylinders which permit a compact, space-saving inter-cooler arrangement and easy installation. The "one-connecting-rod-to-a-crankpin" feature plus its all-'round rugged construction insure 24-hour a day dependability with minimum maintenance. Available with electric motor or other drives in moderately rated sizes 200 to 450 hp, the VCE-3 assures "safety-plus" operation at 500 lbs. Write for Bulletin 733. *Chicago Pneumatic Tool Company, 8 East 44th St., New York 17, N. Y.*

Station Air—Type "Y" Compressor—Compact, economical and easily installed—requires simplest of foundations—needs no alignment. Available from 75 hp to 250 hp, 410 cfm. to 1663 cfm. Write for Bulletin 766.

Instrument Air—CP Oil-Less Cylinder Compressors—need no oil or other lubricant. Designed for continuous service with minimum attention. Ask for Catalog 728 Supplement D.

Portable Air Compressors—Have CP gradual speed regulator—paces engine speed to air demands for fuel economy. Available from 60 cfm. to 600 cfm. Ask for Bulletin 758.

Chicago Pneumatic

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

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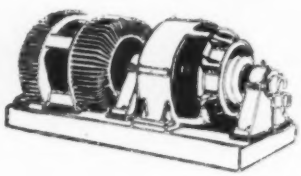
UNDISPLAYED RATE
$1.50 a line. Minimum 3 lines. To figure advance payment count 5 average words as a line. (See ¶ on Box Numbers.)
POSITION WANTED and Individual Selling Opportunity Wanted undisplayed rate is one-half of above rate, payable in advance.
PROPOSALS, $1.50 cents a line an insertion.

INFORMATION
BOX NUMBERS count one additional line in undisplayed ads.
DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).
EQUIPMENT WANTED or FOR SALE Advertisements acceptable only in Displayed Style.

DISPLAYED RATE
The advertising rate is $16.25 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.
AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. PR.

NEW ADVERTISEMENTS, N. Y. Office, 330 W. 42nd St., N. Y., for the November issue closing October 9th

SEARCHLIGHT EQUIPMENT SPOTTING SERVICE



This service is aimed at helping you, the reader of POWER, locate used and surplus new power equipment not currently advertised (this service is for user-buyers only).

Just send in the specifications of the equipment wanted on the coupon below, or on your own company letterhead, to

Searchlight Equipment Spotting Service
c/o POWER
330 W. 42nd St., N.Y. 36, N.Y.

Your requirements will be brought promptly to the attention of the used equipment dealers advertising in this issue. You will receive replies directly from them.

NO CHARGE • NO OBLIGATION

Searchlight Equipment Spotting Service
c/o POWER
330 W. 42nd St., New York 36, N. Y.

Please help us locate the following used equipment:

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NAME ..... TITLE .....

COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

10/53

MECHANICAL PLANT BETTERMENT ENGINEER

Operating Division of service organization requires Plant Betterment engineers in connection with Public Utility Steam Electric and Diesel Electric Stations, located in eleven countries in Latin America. Applicant should be a college graduate majored in mechanical engineering, and preferably have at least 5 to 10 years experience in the operation and betterment of Steam and Diesel Plants preferably operated by Public Utilities.

Work consists primarily in checking local operations, helping operators solve problems, and when necessary helping start up new installations. Letter applying should give age, education, experience, and state salary expected. Location New York, some travel, Spanish desirable, but not necessary.

P-8919, POWER
330 W. 42 St. New York 36, N. Y.

MECHANICAL DESIGN ENGINEERS

Design Division of service organization requires engineer in connection with overall design and particularly with detailed design of mechanical equipment in Steam Electric Stations. Headquarters New York. Some travel to properties required. Organization services utility properties located in eleven Latin American countries.

Letter of application should state age, education, experience and salary expected.

P-8921, POWER
330 W. 42 St., New York 36, N. Y.

REPLIES (Box No.):
Address to office nearest you
NEW YORK: 330 W. 42 St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

POWER PLANT assistant foreman to assist in supervising the operation and maintenance of an 8000 K.W. steam plant located S.A. State age, education and give experience record. P-9224. Power.

EMPLOYMENT SERVICE

SALARIED PERSONNEL, $3,000-$25,000. This confidential service established 1927 is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. G, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

MECHANICAL ENGINEER. Graduate. Registered. Age 32. 8 years service engineer leading boiler manufacturer. Desires to return to South as sales engineer. PW-8934, Power.

(Continued on the opposite page)

PROJECT MANAGER

power plants

Internationally known engineering organization, located on the East Coast, requires the services of a graduate ME with a minimum of 10 years experience in the design and development of chemical, oil refinery or other large industrial power plants.

This is a permanent, top-level position and offers a high salary, an unusually liberal pension plan and vacation policy, and executive insurance. Traveling and moving expenses will be paid.

Please submit complete details of education, background, experience, past salaries, and initial salary requirements. Our personnel have been advised of this opening.

BOX 120, ROOM 1201
230 WEST 41st ST., NEW YORK 36

WANTED

MECHANICAL ENGINEERS

Established consulting firm, New York area, desires Mechanical Engineers, capable supervising starting, testing, operating and correcting troubles of steam electric station equipment. Plant betterment work involving considerable travel. Technical education and plant operating or betterment experience required. State education, experience and salary desired.

P-8516, POWER
330 W. 42 St., New York 36, N. Y.

POSITIONS WANTED

(Continued from opposite page)

ENGINEER: CHIEF—Plant—Maintenance graduate—several years heavy experience. Steam and electrical generation and distribution—refrigerating and air-conditioning etc. General plant Master Mechanic. Utility or Industrial. Domestic or Foreign. "Engineer" 331 W. Marguette Road, Chicago 21, Illinois.

POSITION WANTED—Chief Operating Engineer. Stationary Engineer with 16 years experience in operation and maintenance of medium size steam plants desires position as Chief Operating Engineer, U. S. or Canada. At present employed as Assistant Chief Operating Engineer, thoroughly experienced with both stoker and oil-fired plants. Valid reasons for desiring advantageous change in location. Married. Reliable. Age 45. Good health. PW-9083, Power.

POWER ENGINEER seeking position as supervisor of moderate size steam power plant. Age 30, 8 years experience (3 years as supervisor) operation and maintenance of power plant and air conditioning equipment. Will consider job as operator which could lead to supervisory position. PW-8728, Power.

SALES REPRESENTATIVES

Aggressive young sales engineering group seek instrument and pump lines for representation in Metropolitan N. Y., N. J., and Conn.

RA-9159, POWER
330 W. 42nd St., New York 36, N. Y.

BUYERS OF SURPLUS COPPER INSULATED WIRES AND CABLES

No lengths too long or too short
TELEPHONE: EASTGATE 7-4778

PIERCE CABLE CO.
2668 CLYBOURN AVE., CHICAGO 14, ILLINOIS

CONTROLLER SYSTEM FOR SALE

Including: Patents, drawings, patterns, present controllers (as constructed), jigs, fixtures and parts.

THE CONTROLLERS are of a simple modern design and can be used for the purpose of regulating speed, pressure, flow, or mixtures to very close limits.

TRANSMISSION for desired effect is liquid (oil, water, etc.) of suitable pressure, the rate of flow being closely controlled by a hydraulic relay of special design.

THE RELAY is neat and compact; Internal parts are jig drilled for openings from one to ten. The desired number of ports can be pre-selected to help proportionate amount of liquid required for the correct movement of power units of different sizes and power. This feature tends to eliminate wire drawing, but will not have any effect in the use of ratio adjustments.

There are a number of safety features, such as pre-determined open or closed position of any regulated unit, in case of regulator failure; fast and accurate hydraulic movement with all controls at a central point.

No stuffing boxes required. Can be master or individually controlled by entrapment.

TWO DIFFERENT MODELS are available for inspection and testing.

THE DESIGNER solicits inquiries from firms interested in further diversification, or those already manufacturing controls.

BO-8780, POWER
520 N. Michigan Ave., Chicago 11, Ill.

GET 2nd ENGINEER PAPERS IN 1 YEAR

(Yes, get better stationary engineers License!)

No correspondence school bother. Nationally-known Chief Stationary Engineer Frederick C. Walker's 100-Question, 100-Answer Bulletins give you the straight dope quick. Send $3 to Walker & Collins, 524 Ashland Ave., Buffalo 22, N. Y. for first set today. Keep working. Save year.

UNUSUALLY PROFITABLE SALES OPPORTUNITY

for **INDUSTRIAL OIL & GAS BURNER SALES ENGINEERS** *and* **STOKER DEALERS**

TO SELL the NEW Industrial FLO-MATIC JET FYR-FEEDER Wood waste and/or Coal STOKER

Our EQUIPMENT IS WITHOUT EQUAL and PAYS FOR ITSELF
usually in less than one year

FYR-FEEDERS are being used in combination with OIL and GAS BURNERS

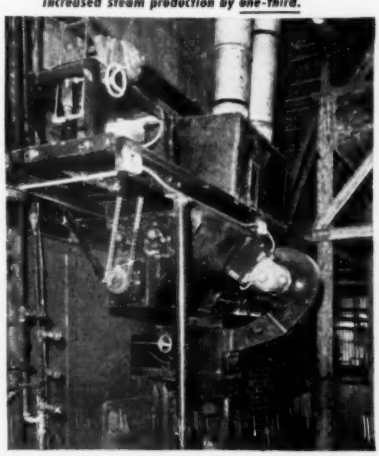
FYR-FEEDER is a Profit-Maker

EXAMPLES of LARGE SAVINGS:

✓ Lumber Company saves approximately $45 daily on labor and has increased lumber production approximately 20%.

✓ Veneer and Plywood Company saves $40,000 on coal and approximately $40 per day on labor and buy less purchased power.

✓ Lumber and Veneer Company saves on purchased gas and labor and has also increased steam production by one-third.



Flo-Matic automatically measures, feeds and burns Wood (planer) Chips, Sawdust, Cheaper Coal Sizes, Coke Breeze, Hogged Wood and other Solid Fuels and makes very large savings!

FYR-FEEDER ENGINEERS Division

AMERICAN COAL BURNER and WOOD STOKER CORPORATION

18R EAST ERIE STREET • CHICAGO 11, ILLINOIS

Since 1899 • Engineers • Manufacturers

Telephone SUperior 7-3264

RE-MA-BILT BELYEA MOTORS

THE TRADE MARK WITH A MEANING SUCCESSFUL OPERATION GUARANTEED

*45th Year of Service—Member of A.R.A.**

A. C. MOTORS

3 ph. 60 Cycle

SYNCHRONOUS

Qu.	HP	Make	Type	Volts	Speed
1—	4350	Cr. Wh.		4160/13800	514
2—	3500	G. E.	TS	2300	257
1—	2500	G. E.	ATI	2300	720
2—	2100	G. E.	ATI	2300	360
2—	2000	Whse.		2300	120
1—	2000	G. E.	ATI	2200	900
2—	1750	G. E.	ATI	2300	3600
3—	735	G. E.	ATI	2200/12000	600
1—	500	Ideal	SM	2300/4150	1800
1—	450	Whse.	Eng.	2200	128.5
1—	450	Whse.		2300	450
2—	350	G. E.	TS	2200	150
1—	300	Whse.		2300	720
1—	150	Whse.		440	600

SLIP RING

1—	1500	G. E.	MT-498	2300	360
1—	1500	ABB		2300	720
1—	1200	G. E.	MT-26	2300	275
2—	1000	A. C.	Mill	2300	240
1—	500	Whse.	CW	550	360
1—	500	G. E.	IM	2300	900
1—	450	G. E.	IM	440	720
1—	400	Whse.	CW-1218	2200	435
1—	400	Whse.	CW	440	514
1—	350	G. E.	MT-442	2300/4000	253
1—	350	G. E.	IM-17A	440/2300	720
1—	300	G. E.	MT-565Y	2300	900
1—	250	G. E.	MT-424Y	4000	250
1—	250	G. E.	MT-559S	2200	1750
1—	250	A. C.		550	600
1—	200	Cr. Wh.	26QB	440	505
1—	200	G. E.	IM	440	435
1—	200	G. E.	MTP	440	1170
1—	150 new	Whse.	CW	2300	450
1—	150	G. E.	IM-16	440	600
2—	125	A. C.		440	865
1—	125	A. C.		440	720
4—	125	G. E.	MT-566Y	440/2200	435
2—	100	G. E.	IM	440	600
1—	100	G. E.	IM	2200	435
4—	100	A. C.		440	615
4—	100	G. E.	MT	440/2200	435

SQUIRREL CAGE

2—	650	G. E.	FT559BY	440	3750
2—	450	Whse.	CS	2300/4150	354
1—	200	G. E.	IK-17	440	580
3—	200	G. E.	KT-557	440	1800
1—	200	G. E.	IK	440	865
1—	75/150	G. E.	IK	440	450/1800
1—	150	Whse.	CS	440	580
1—	150	Westghse.	CS856S	440	880
1—	125	Whse.	MS	440	485
2—	125	Al. Ch.	ARW	2200	1750
2—	100	G. E.	IK	440	580
1—	100	G. E.	IK-Vert.	2200	450

D. C. MOTORS

Qu.	HP	Make	Type	Volts	Speed
1—	2200	G. E.	MCF	600	300/500
1—	2000	Whse.	Mill	600	230/460
1—	940	Whse.	QM R Brg.	250	140/170
1—	900	Whse.		250	450/550
1—	825	Whse.	Mill	250	90/180
1—	600	A. Ch.	Mill	230	400/800
1—	500	Whse.	Mill	600	300/900
2—	450	Whse.		550	415
1—	400	G. E.	MCF	550	300/1050
1—	300/400	G. E.	DYNA	250	1325/2700
1—	300	Whse.	CB-5094	230	575/1150
1—	200/300	G. E.	MPC	230	360/920
1—	250	G. E.	MPC	230	400/500
1—	200	Rel.	1970T	230	720
1—	200	Whse.	CB-5113	230	400/800
1—	150	G. E.		600	250/750
8—	150	Cr. Wh.	83H	230	890
1—	150	Cr. Wh.	CMC-65H	230	1150
1—	150	Whse.	SK-201	230	360/950
1—	150	Whse.	SK-151 B	230	900/1800
1—	125	G. E.	MDS-416	230	415
4—	75	C. W.	53H-TEFC	230	860
1—	50/120	G. E.	MFC	230	250/1000
2—	100	Whse.	SK-181	230	450/1000
1—	60	El. Dy.	28-8	230	525/1050
2—	50/60	Whse.	SK-170	230	400/1200
1—	50	G. E.	CO-1810	230	725
1—	50	Whse.	SK-170	230	350/1050
1—	50	G. E.	RCP-31B	230	1700

MOTOR GENERATOR SET

3 Ph. 60 Cycle

Qu.	KW	Make	Speed	D.C. Volts	A.C. Volts
1	3000 (3U)	G. E.	514	600	4000/13200
1	2000	G. E.	514	600	13800/4000
2	2000	G. E.	450	250	2400
1	2000(25 cy)	G. E.	500	660	6600/11000
2	1750	G. E.	514	250	2400
1	1500	G. E.	720	600	6600/13200
1	1500	G. E.	600	600	2300/4150
1	1500	C. W.	514	115	4160/13800
2	1000	Whse.	900	600	2300/4100
1	1000	G. E.	900	260	6600
1	1000(3U)	G. E.	900	250	2400/4800
2	750	Whse.	900	275	2300/4160
1	750	C. W.	514	115	2300
1	600	G. E.	720	250	440/2300
1	500	Whse.	900	125/250	440
1	500	Whse.	1200	125/250	2300
1	500	G. E.	720	125	2300/4000
1	400	G. E.	720	250	440/2300
1	150	G. E.	1200	250	2300
1	150	Whse.	1200	275	2300
1	150	G.E.	1175	125	440
1	140(3U)	Cr. Wh.	690	125-250	2300
1	125	G. E.	1200	125	440
1	100	Delco	1200	125/250	440
1	100	G. E.	1200	250	2300/4000
2	35	Whse.	1750	125/250	2200

FREQUENCY CHANGERS

Qu.	KW	Make	Cycles	Voltage
1—	12500	Whse.	60/25	13200x13200
1—	3000	G. E.	25/60	4000/2300x2300/4000
1—	2500	G. E.	25/60	2400x4150
1—	2000	G. E.	25/62½	2300/4160
1—	2000	Whse.	25/62½	2300/2300
1—	1000	G. E.	25/58	4400/2300
1—	500	A. C.	25/60	11000/2300V

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	1000	Moore	Auto - Ext. Cond. 175/200# I.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.
	1000	G. E.	Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.B.P., 480/3/60.
	750	G. E.	Condensing 425#-725* TT I.S.P. 440V. 3 ph. 60 cy.—New—1944
	750	Whse.	—Non-condensing 135# I.S.P. 40# B.P. 750 Kw. 280 V. D.C.
	500	Moore	Non-condensing—150/200 lbs. I.S.P. 5/35 lbs. G.B.P.—3/60/480 volts direct connected exciter.
	500	G. E.	Non-condensing 175/200 lbs. I.S.P., 5/30 G.B.P., 480/3/60
	300	G. E.	Non-condensing 10/175# I.S. P. 5/15# B.P. 480V. 3 ph. 60 cy.
	200	Whse.	Non-condensing 150# I.S.P 7# B.P. 240 V. 3 ph. 60 cy.

TRANSFORMERS

60 Cycles

Qu.	KVA	Make	Type	Ph	Voltages
1	5000	Whse.	OISC	3	3300x26400/13200
1	3500	G. E.	WCT	3	13800/6900x2300/440
1	2500	Whse.	OISC	3	26400/13200x460
3	2000	G. E.	HVDDJ	1	66000x13800
2	1750	G. E.	WCT	3	13800/6900x2300/410
3	1000	G. E.	H	1	2200x480
1	1500	G. E.	HT	3	13200x2300
3	1250	G. E.	H	1	6600x550
4	1000	Mol.	O	1	44000x2400/4160
2	1000	Pitts.	OISC	3	2300x460
4	1000	Al. Ch.	OISC	1	2300/4000x460
3	1000	Wagner	OISC	1	13200x220/440
2	300	Kuhl	OISC	3	13800x460
3	200	Whse.	O15C	1	13200x120/240
1	150	G. E.	HT	3	25000x120/208
3	150	Whse.	OISC	1	33000x2300/4000
2	75	Upte	OISC	3	4160x240

*American Rebuilders Association — Member Body of A.S.A.

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OCTOBER SPECIAL

STEEL MILL DRIVE ELECTRICAL EQUIPMENT

We own and offer, in original crates, the following G.E. NEW steel mill equipment:

2—350 HP, 375-750 RPM, 230 V., MDP-422 Mill Motors w/blower and fan.

1—250 HP, 410/820 RPM, 230 v., MDP-420 motor W/blower and fan

3-unit synchronous motor generator set—suitable for 60 cycle

1—1250 KW, 750 RPM, 600 v., shunt wound DC gen. 40°C rise

1—750 KW, 750 RPM, 250 v., shunt wound DC gen. 40°C rise

1—3000 HP, 750 RPM, 6000 v., 3 ph., 50 cy., .8 PF, 40°C rise

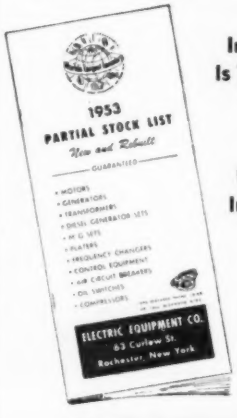
3-unit synchronous motor generator set—suitable for 60 cycle

1—400 KW, 750 RPM, 250 v., shunt wound DC gen. 40°C rise

1—750 KW, 750 RPM, 250 v., shunt wound DC gen. 40°C rise

1—1750 HP, 750 RPM, 6000 v., 3 ph., 50 cy., .8 PF, 40°C rise

Control equipment for the above is available. Your inspection is invited.



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ELECTRIC EQUIPMENT CO.

ROCHESTER 1, N. Y.

Phone LD 65

1000 KW.

WESTINGHOUSE CONDENSING TURBINE-GENERATOR

MODERN • VERY GOOD CONDITION • A COMPLETE UNIT 400 lbs.

Above Westinghouse is a 1000-KW @ 80%—P.F., 1250-KVA., 400# psig., 3/60/2300-v. Is Complete with all piping and accessories, Surface Condenser, Switchboard, Shaft Exciter, Etc. Turbine Serial #12580: Generator #4791874. IMMEDIATE DELIVERY.

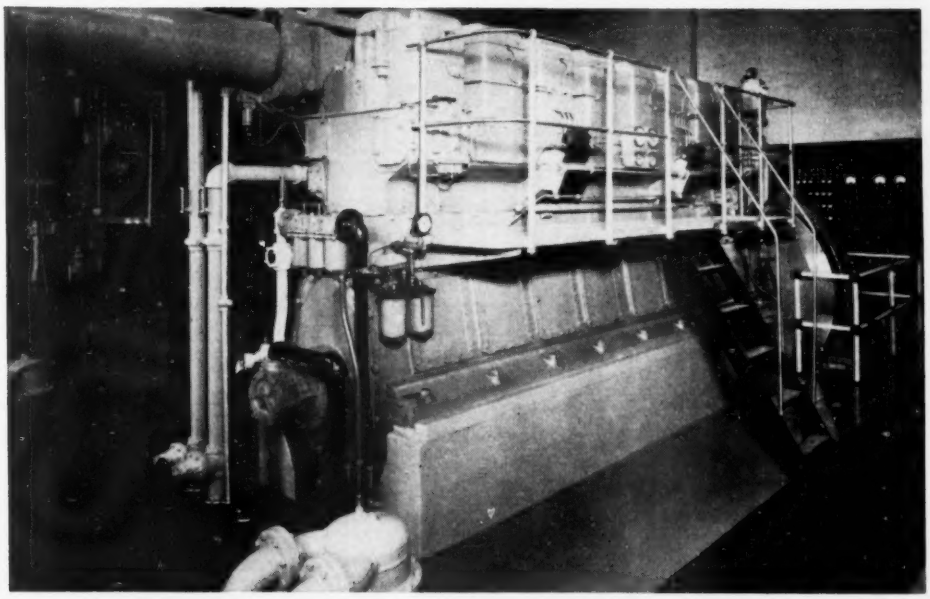
WE CAN DELIVER FROM STOCK ALMOST ANY TURBINE SET FROM 300 to 5000-KW. Condensing or Non-Condensing. ALSO BOILERS & DIESEL ENGINES.

Send Us Your Specifications

2250-KVA., G.E. DESTROYER ESCORT TURBINE-GENERATOR, 440# psig., 750° F.TT.

3350 HP

COMPLETE COOPER-BESSEMER POWER PLANT: 5-670 HP., Engines 400-RPM., 2300-volt. Each Equipped with 475-KW. IDEAL GENERATORS.



Above 5-670-HP., Engines (our own property) Still on Foundations. Will be run for Inspection. Will sell as Complete Unit, or Engines separately. Each engine equipped with switchboard and all appliances for separate operation. Is the most complete and finest plant we have ever owned. Is priced at a fraction of its original cost. Large lot of spare parts. INVESTIGATE NOW. ENGINES ARE LIKE NEW MACHINES.

ALSO OWN AND OFFER 2—Fairbanks-Morse, 1600-HP., O.P., Diesel Engines, 720-RPM., or 1800-HP., at 800-RPM. Same as New. Immed. Delvy.

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A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse syn cond		4000/2300	900
625	Gen Elec	ATB	2300	450
625	G E 25 cycle	ATB	2300	750
600	Gen Elec	ATB	480	900
625	El Machy	Late	240/480	1200
485	Allis Ch	1 brg	480	400
350	El Machy	1 phase	480	1200
312	Gen Elec.	ATB	240/480	600
275	G. E. 25 cycle	ATI	480	750
225	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
150	Allis Ch.		240/480	1200
150	Gen. Elec.	ATB	2300	900
150	Whse		2300/480	600
125	Gen. Elec (2)	ATB	240/480	900
112	Gen. Elec.	ATB	240/480	900
90	Gen. Elec.	ATI	240/480	1200
75	Gen. Elec.	ATI	240/480	1200
75	El. Machy		2300	900
56	G. E.	ATB	240/480	1200

SPECIAL PURCHASE

2—DC 55 V. 3600 Amp. M-G Sets

Input—300 H.P. Whse. synch. motor, 3/60/220/440 V. 720 RPM, w/exciter.

Output—200 KW. generator, DC 55 V. 3636 amp. 720 RPM, w/exciter.

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MECW	125/250	1200
250	Alls. Ch. b.b.	EW	350	1200
105	Century b.b.	1500 amp.	70	1200
100	Allis. Ch.	E	125	1200
100	Whse.	SK	250	1200
75	Cr. Wh. b.b.	CCD	250	1500
75	Cont. b.b.	D109X	125	1200
75	Gen. Elec. (2)	CD115	250	1500
75	Whse.	SK	250	1200
60	Whse.	SK160	250	1000
50	Whse.	SK	250	1100
50	Allis. Ch.	EW	125/250	1200
50	Gen. Elec.	RC	125	1200
40	F. Morse b.b	DH	125	1800
40	Gen Elec.	RC	600	1750
25	Whse.	SK93	125	1750
20	Gen. Elec.	RC	125	1150
15	Star b.b. (10)	SQ	250	1500

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Gen. Elec.	MPC	250	500
300	Allis. Ch. b b	EW	350	1000
200	Al Ch. b.b.	E	250	500/1000
100	Gen. Elec	CD115	230	1750
100	Whse.	SK	230	850
75	Whse.	SK170	230	635
75	G. E (2)	CD 115	230	1150
75	Whse.	SK163	230	850
60/75	Gen. Elec.	C	230	500/1200
50	Whse.	SK150	230	750
50	Reliance b.b.	65IT	230	750
50	Gen. Elec.	CD123	230	550/1200
50	Gen. Elec.	RC33	115	1100
50	Cr.Wh.b.b.(3)	FH	230	1750
40	Gen. Elec. (2)	CD103	230	1150
40	Gen. Elec.	RC32	550	1200
40	F. Morse b.b.	DH 120	115	1750
30	Imperial b.b.	D69	230	400/1600
30	Gen. Elec.	LC	230	500/1500
30	Whse.	SK110L	230	1150
30	Star b.b. (3)	SB	230	1750
25	Whse.	SK150	230	300/1200
25	Gen. Elec.	CD85	230	1750
25	Gen. Elec.	CD105	230	575/1720
20	Century b.b.	DN330	230	3505
20	G. E. series	CO-1826	230	875
20	Whse. b.b (2)	SK97	550	900

A. C. MOTORS

HP	Mfr.	Type	Volts	Speed
800	G. E.	Slipring	2300	400
750	Whse.	Synch.	2200/4000	900
700	G. E.	Synch	2200	514
600	G. E.	Synch.	220/440	257
600	E. M.	Synch.	480	1200
600	G. E. (2)	Synch.	2200/440	360
550	G. E.	Sq. Cage	2200	3600
500	G. E.	Sq. Cage	6600/4000	1800
500	G. E.	Synch.	440	900
450	Whse.	Sq. Cage	2200	514
400	G. E.	Synch.	440	450
400	Allis. Ch.	Sq. Cage	2200	1200
350	G. E.	Slipring	2200/440	300
350	Whse. (2)	Slipring	2300	450
300	Gen. Elec.	Slipring	2200/440	720
300	Al. Ch.	Sq. Cage	2200/440	720
300	El. Mach.	Synch.	2200	360
300	Whse.	Synch.	2200/440	600
300	Al. Ch.	Slipring	2300	514
300	G. E.	Slipring	440	360
250	G. E.	Slipring	2300	450
250	G. E.	Synch.	220/440	720
250	Whse. (2)	Sq. Cage	2200/440	1200
250	L. A. (2)	Sq. Cage	2200	1800
225	G. E.	Synch.	220/440	900
200	Allis. Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2200/440	720
200	G. E.	Sq. Cage	220/440	600
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	G. E.	Slip Ring	220/440	600
200	E. M.	Synch.	220/440	1200
200	G. E.	Sq. Cage	220/440	1200
200	G. E.	Slipring	220/440	360
200	Whse.	Sq. Cage	220/440	1800
200	Rel. b.b.	Sq. Cage	220/440	1200
200	E. M.	Synch.	220/440	514
175	Whse.	Synch.	220/440	360
160	Whse.	Synch.	220/440	600
150	Whse.	Sq. Cage	220/440	900
150	G. E. TEFC	Sq. Cage	2200	3600
150	Allis Ch.	Slipring	2200/440	720
150	G. E. (2)	Sq. Cage	2200/440	720
150	G. E.	Slipring	220/440	450
150	Allis. Ch.	Sq. Cage	2200/440	1200
150	Rel. b.b.	Sq. Cage	220/440	1800
150	Allis Ch.	Sq. Cage	440	450
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G. E. (2)	Slipring	220/440	600
125	G. E.	Slipring	220/440	450
125	E. M. (2)	Synch.	220/440	1800
125	Allis. Ch. b.b.	Sq. Cage	2200	900
125	G. E	Slipring	2200/440	720

M-G SETS

KW	Mfr.	Input V	Output V
500	Whse.*	2300 AC	250 DC
300	Whse.*	2300 AC	250 DC
300	Allis. Ch.	2200/440 AC	125/250 DC
300	Whse.*	2300 AC	600 DC
250	Allis. Ch.	2200/440 AC	350 DC
250	Cr. Wh.*	2200/4000 AC	250 DC
200	Whse.* (2)	220/440 AC	55 DC
200	G. E.*	220/440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
105	Century b.b.	220/440 AC	70 DC
100	Al. Ch.	220/440 AC	125 DC
100	Delco b.b.	220/440 AC	125/250 DC
90	G. E.* (2)	220/440 AC	125 DC
80	Star* b.b.	220/440 AC	240 DC
75	Cont. b.b.	220/440 AC	125 DC
75	Whse.	220/440 AC	250 DC
60	Gen. Elec.*	220/440 AC	60 DC
50	Whse.	220/440 AC	250 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Allis. Ch.	220/440 AC	125/250 DC
45	Gen. Elec.*	220/440 AC	60 DC
40	Gen. Elec.	220/440 AC	600 DC
30	Otis (5)	220/440 AC	250 DC
25	Whse.	220/440 AC	125 DC
25	Gen. Elec.	220/440 AC	250 DC
20	Star b.b.	220/440 AC	120 DC

*Synch. motor.

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SLIP RING MOTORS

220 or 440 volt, 60 cycle, 3 phase, slip ring Motors Rebuilt

H.P.	Make	Type	Speed	Description
400	G.E.	I-M	1200	S.B.
300	G.E.	I-M	1200	S.B.
200	G.E.	I-M	1200	S.B.
150	G.E.	I-M	1200	S.B.
150	G.E.	I-M	1800	S.B.
100	G.E.	MT-300	1800	S.B.
100	G.E.	I-M	900	S.B.
100	G.E.	I-M	720	S.B.
75	G.E.	MT-343	1200	S.B.
75	G.E.	I-M	900	S.B.
75	West.	CW	720	S.B.
75	G.E.	I-M	720	S.B.
60	G.E.	MT-333	1800	S.B.
40	G.E.	I-M	1800	S.B.

BRAND NEW SQUIRREL CAGE MOTORS

Totally enclosed, fan cooled, explosion proof, open 220 or 440 Volt, 60 Cycle, 3 Phase

H.P.	Make	Type	Speed	Description
150	G.E.	K-6326	3600	TEFCBB
150	G.E.	K-6326	1800	TEFCBB
125	G.E.	K-6326	1200	TEFCBB
100	West.	CS-6075	1800	TEFCBB
100	West.	CS-504	1800	B. B. open
75	West.	CS-504	3600	TEFCBBXP
75	A.C.	ARZ	1800	TEFCBBused
75	West.	CS-504	1800	TEFCBBXP
75	West.	CS-445	1800	B. B. open
75	F.M.	QS-445	1800	B. B. open
75	West.	CS-505	1200	TEFCBBXP
60	West.	K-5945	1800	TEFCBBXP
60	G.E.	OG-44	1800	TEFCBBXP
60	L.A.	QS-444	1800	B. B. open
60	F.M.	FB-404	3600	B. B. open
50	Master	K-445	1800	TEFCBBXP
50	G.E.	K-405	1800	TEFCBB
50	G.E.	CS-445	1200	S. B. drip
50	West.	K-505	900	S. B. open
50	G.E.	AR-444	3600	TEFCBBXP
40	A.C.	KF-3655	3600	TEFCBBXP
40	G.E.	CS-405	1800	B. B. Splash
40	West.	K-405	1800	TEFCBB
40	L.A.	404	1800	TEFCBBXP
40	G.E.	CS-5045	1800	B. B. open

REBUILT SQUIRREL CAGE MOTORS

220 or 440 Volt, 60 Cycle, 3 Phase, Open

H.P.	Make	Type	Speed	Description
200	Wagner	RP-2-26	1800	S. B.
200	Wagner		1200	S. B.
200	G.E.	K-564	900	B. B. new
150	West.	CS	1800	S. B.
150	G.E.	I-K	1200	S. B.
150	G.E.	I-K	720	S. B.
100	West.	CS	1800	S. B.
100	G.E.	I-K	1800	S. B.
100	G.E.	I-K	1200	
100	G.E.	KT-347	1200	S. B.
100	West.	MS	1200	S. B.
100	West.	CS	900	S. B.
100	G.E.	I-K	720	S. B.
75	West.	CS	1800	S. B.
75	West.	CS	1200	S. B.
75	G.E.	I-K	900	
75	G.E.	KT-343	1200	S. B.
75	West.	CS-WL-607	1200	S.B. B.
75	G.E.	KT-552	900	S. B.
75	G.E.	KT-352	900	S. B.
75	G.E.	KT-346	720	S. B.
60	G.E.	KT-333	1800	S. B.
60	G.E.	I-K	1200	S. B.
60	West.	CS	1200	S. B.
60	G.E.	KT-346	900	S. B.
60	G.E.	I-K	900	S. B.
50	G.E.	I-K	1800	S. B.
50	Cr. Wh.	25R	1800	S. B.
50	G.E.	KT-327	1800	S. B.
50	G.E.	KT-336	1200	S. B.
50	West.	CS	1200	S. B.

We have in stock explosive proof motors 220/440/60/3 ranging in HP from ½ to 50 HP 900 to 1800 RPM. We also carry in stock a large quantity of used electric motors from 1 hp up to 500 HP., generators, transformers and control equipment. Upon receipt of your inquiries, we shall be glad to quote.

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Chicago Electric "Rebuilts" can be purchased at substantial savings over new equipment and their like new performance backed by a full guarantee represents a sound dollar investment. The next time you need electrical power equipment, call *Chicago Electric*, and see for yourself why many others in industry always do!

SQUIRREL CAGE MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2200 volts or higher)

HP	Make	Type	Speed
1750	*G. E.	K	3600
1000	*G. E.	K6347S	1800
750	*A. C.	TEFC	1800
750	*G. E.	KT	720
700	G. E.	FT	3600
500	*A. C.	6316SW	1800
400	*G. E	KF559	3600
300	*West.	CS	3600
250	*L. Allis	OGX148	720
250	G. E.	IK	600
200	*G. E.	FT549Y	3600
200	A. C.	ARWX	3600
200	*G. E.	IK13B	1800
200	A. C.	ARWWT	600
200	G. E.	IK17	600
200	*West.	CS	600
200	*G. E.	K6325S	514
150	A. C.	AR DP	3600
150	*A. C.	AN	1800
150	G. E	IK13A	1800
150	G. E.	IE-K	1200
150	G. E.	KT558	900
150	*G. E	KT566 TEFC	720
150	G. E.	IK16	600
150	*West.	CS 3-brg.	600
125	West	CS504S	3600
125	*A. C.	AR226	1800
125	*Reliance	AA6085 BB	900
125	A. C.	AR	900
100	L. Allis	EX114SExPr	3600
100	*G. E.	FT542Z	1800
100	G. E	FTRP543	1800
100	*West.	CS	1800
100	A. C	AW	1200
100	G. E	IK13A	1200
100	U. S.	CFU (vert)	1200
100	*West.	CS (vert)	1200
100	*West.	CS774C	900
75	West.	CS445S	3600
75	G. E.	KT537	1800
75	G. E.	IK11A	1800
75	A. C.	AR505	1200
75	Howell	TEFC	1200
75	G. E.	KF542 BB	1200
75	*A. C.	AR (vert)	900
75	A. C.		900
75	A. C.	AN	720
75	G. E.	IK	600
75	Fair-Mor	H24B BB	514
60	G. E.	KF444Z	3600
60	*West.	CS504S	1800
60	A. C.	APZ445S TEFC	1800
60	*West.	CS505S TEFC	1800
60	*G. E.	KT537	1800
60	A. C.	APZ504U TEFC	1200
60	West.	CS752C	1200
60	West.	GS857C TEFC	1200
60	A. C.	AR504U	1200
60	*G. E.	KT343	1200
60	G. E.	KT343	1200
60	Cr.-Wh	SC505	1200
60	A. C.	AR823	900
60	A. C	AR826F	514
50	G. E.	K404	3600
50	West.	CS205S	3600

Hundreds of smaller motors! WRITE FOR STOCK LIST

SPECIAL OFFERING

BRAND NEW, Surplus Stock 2 HP to 60 HP HIGH-TORQUE, HIGH-SLIP MOTORS Designed for punch press and similar service—good for standard applications, too. Write for list and BIG DISCOUNT.

SLIP RING MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2200 volts or higher)

HP	Make	Type	Speed
2000	*G. E.	MT-12	600
2000	*G. E.	MT-30	237
1500	*G. E.	MT-30	240
1250	*West.	CW	600
1000	*West.	CW	250
700	*A. C.	ANY	720
500	*G. E.	IM	3600
500	*G. E.	MTP	1800
500	*G. E.	MT	450
500	West.	CW	350
400	A. C.	3-brg	450
400	*G. E.	MT412	450
350	West	CW	900
300	*G. E.	IM13A	1800
300	*G. E.	MT410	450
250	West.	HF15H	600
200	G. E.	IM15	1200
150	G. E.	MT549 BB	1800
125	*G. E.	MT549	1800
125	G. E.	IM15A	600
100	A. C.	ANY	900
100	G. E.	IM13A	1800
100	G. E.	IM15A	450
75	Northw'n	HW50	1800
75	G. E.	MT347	1200
75	G. E.	MT356	900
75	G. E.	IM	720
75	G. E.	IM14	600
60	West	CW762C	900
50	G. E.	IM11A	1800
50	*A. C.	ARY	1800
50	West.	CW636A	1200
50	G. E.	MT346	720
50	G. E.	IM14	450
40	*G. E.	MT532	1200
40	G. E.	MT336	1200
35	Fair-Mor.	UAB (vert)	1800
35	G. E.	IM	1200
30	G. E.	MT532	900
30	G. E.	MT326	1200
25	G. E.	MT522	1200
25	G. E	MT526	900
25	G. E.	MT536	720
20	G. E	MT322	1200
20	G. E.	IM	900
20	G. E.	MT322	900
20	G. E	IM11A	720
20	G. E.	IM12	600
15	L. Allis	OH326	1800
15	A. C.	ARY326	1800

TRANSFORMERS

Dry Type Air Cooled
STANDARD or SPECIAL RATINGS
Made to your Specifications
Any Quantity Quick Deliveries
Send us your Inquiries for Prompt Quotations

TRANSFORMERS

KVA	Make	Phase	Primary	Secondary
1000	West.	3	4800	480
850	West.	3	34160	455
667	G. E.	1	3000	480
500	American	1	2400	240/480
400	West. (air)	3	12000	213
300	G. E.	3	13800	240/480
300	G. E.	3	2400	240/480
250	G. E.	1	4160	240/480
200	Wagner	1	2400	575
167	A. C.	1	2400	120/240
100	Pittsburgh	1	2400	575
100	Pittsburgh	1	2400	240/480
100	American	1	2400	240/480
100	G. E. (Py'l)	1	2400	120/240
50	West.	1	2400	120/240

AC SYNCHRONOUS MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2200 volts or higher)

HP	Make	Type	P.F.	Speed
1420	*West.		.7	900
800	*G. E.		1.0	1800
710	*G. E.	ATI	1.0	720
700	*G. E	TS975Z	1.0	1200
600	*G. E.	TS7640	1.0	900
600	*G. E.	TS	1.0	600
600	*G. E.	ATI	1.0	240
400	West.	HG	1.0	900
300	G. E.	ATI	.8	1200
300	G. E.	ATI	.8	900
300	*G. E.	ATI	1.0	720
300	Ideal	SNS	1.0	257
250	*Cr. Wh.	251S4	1.0	1800
220	*West.		1.0	600
190	El. Mhy.	2S	1.0	720
175	*West.	HR	1.0	360
150	*West.	HR	1.0	300
125	*G. E.	ATI	1.0	900
125	*El. Mhy.		1.0	900
125	*G. E.	TS	1.0	277
115	El. Mhy.	EM	1.0	240
100	*G. E.	ATB	.8	900
100	*West.		1.0	900
100	Ideal	SNS	1.0	900
100	G. E.	TS6184	1.0	450
20	Fynn-W	15VRN		1200
15	Ideal			1800
15	Century	ARC365	1.0	1200
7½	Ideal			1800

WE WILL BUY YOUR SURPLUS MOTORS
Hoists, Compressors, Transformers
CASH OR TRADE
Write full details for our OFFER BY RETURN MAIL

AC SYNCHRONOUS GENERATORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2200 volts or higher)

KVA	Make	Type	Speed
1750	*West		900
1500	G. E.	ATI	720
312	G. E.	ATI	900
300	*G. E.	ATI	720
225	G. E.	ATB	600
187	West.	ES	720
100	*G. E.	ATB	900
60	Fair.-Mor.	B	900
55	G. E.	ATB	1200
50	G. E.	ATB	1200
50	West.		1200
50	G. E.	ATB	900

M. G. SETS

KW	Make	AC	DC
2400	West. (3-u.)	4800	525
1000	West. (3-u.)	11000	137/275
500	AC-West.	2300	250
450	G. E. (3-u.)	2300	125/250
400	A. C.	2300	120/240
300	Cr. Wh.	440	250
200	G. E.	440	550
200	West.	2300	275
200	G. E.	440	600
150	G. E.	2300/440	250
150	G. E.	2300/4000	125/250
150	G. E.	440	275
125	G. E.	440	300
125	West.	440	250
100	G. E. (25 cy)	440	125
100	G. E.	2300	250
100	Ridgway	2200	275
100	West.	220	125
100	Elec. Machy.	220	125
90	G. E.	220	250
90	G. E.	440	60
75	Reliance	2300/440	250
75	G. E	440	125
60	A. C	2300	110
50	G. E	440	250
40	A. C.	220	125
35	West.	2200	125
30	G. E.	220/440	250
25	Cr.-Wh.	440	125
20	G. E.	440	250
20	Bogue-GE	550	250
20	Bogue-GE	220/440	125

D. C. MOTORS

Mill Type—Pedestal Bearing Reversing

HP	Make	Volts	Speed
1500	West.	525	600
1200	West.	525	600
1000	West.	450	600

230 Volts—Constant Speed

250	G. E. (550 v)	MPC4	700
200	Cr.-Wh.	CM	500
175	G. E.	ELC	750
100	G. E.	RC34	2500
100	G. E.	RC19	575
100	West.	MC90	460
50	G. E.	RC35	700
50	G. E.	DLC-204	650
35	Cr.-Wh.	CM351	700
30	Cr.-Wh.	CCM	440
30	Spragu	C-60	240/300
25	West.	SK100L	1100
25	G. E.	RC32	900
25	G. E.	RC32	800
25	A. C.	E130	775
25	West.	SK133	575

Many other—1 HP and up
Also Variable Speed and 115 Volt Motors

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REBUILT AND NEW ELECTRICAL POWER EQUIPMENT FOR INDUSTRY

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The Schoonmaker Plants and Warehouses located in Jersey City, N. J. and Sausalito (San Francisco), California give NATIONWIDE SERVICE from Coast to Coast with modern, efficient and reliable facilities.

Our reputation and many years of experience and SPECIALIZATION in Diesel power equipment gives you value that money cannot buy elsewhere.

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PORTION OF ENGINE REMANUFACTURING FLOOR AND ONE OF THE ENGINE TEST STANDS AT OUR SAUSALITO, CALIF. PLANT

A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1980	Nordberg	TS-217	3000	225
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
1000	General Motors	16-567B	1440	720
750	General Motors	12-567	1080	720
500	General Motors	8-278A	750	720
500	Baldwin	VO-8	750	514
500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
480	Worthington	DD-8	700	360
400	Ingersoll-Rand	S-8	600	720
350	Baldwin	VO-6	510	450
320	Enterprise	DSG-6	460	450
300	General Motors	8-268A	450	1200
250	Fairbanks Morse	33-D	375	360
200	General Motors	8-268A	350	900
167	Ingersoll-Rand	S	255	600
160	Buckeye	80	240	600
150	Worthington	CC-4	225	450
100	General Motors	3-268A	150	1200
100	Worthington	BB-5	150	600
60	General Motors	6-71	90	1200

ALTERNATING AND DIRECT CURRENT UNITS
STANDARD AND SPECIAL VOLTAGES AS REQUIRED

ONE YEAR GUARANTEE!

A FEW SPECIALS

BOILERS

Cleaver Brooks model OB25, 8600 lbs. steam, 200 lbs. pressure, Oil fired, "1949"

Combustion Engr. Premier #30, 256 HP semi-portable, steel encased, firetube, 150 lbs. pressure "1949"

1000 H.P. Combustion, 4 Drum, 200#
812 H.P. (2) Combustion, 4 Drum, 300#
500 H. P. (2) BW straight tube 200#
400 H.P. BW 3 Drum, 160# "1949"
250 H.P. BW 3 Drum, 225# "1948"
100 HP Cleaver Brooks, 150# (Package)
70 HP Cleaver Brooks, 15# (Package)

TURBO UNITS, non-condensing

937 KVA GE 480/240 v.; O/15# bp
625 KVA Al.Chal.-Elliott 480/240 v.; O/15# bp
375 KVA Al.Chal.-Elliott 240/480 v.; O/25# bp

STEAM ENGINE UNITS (Uniflow)

375 KVA (2) Wghse.-Skinner, 3/60/600 v.
312 KVA GE-Skinner 240/480 v.
250 KVA (2) GE-Skinner, 240/480 v.
187 KVA Wghse.-Ames vertical, 240/480 v.

DIESEL UNITS (Modern)

1136 KVA (4) FM, opposed piston, 720 rpm
1000 KVA Elliot-DeLa Vergne 200 RPM
438 KVA GE—Winton (General motors)
300 KVA Fairbanks Morse 277 rpm
220 KVA (2) Wghse-Buckeye "E" 400 rpm
187 KVA Ideal-Buckeye "E" 400 rpm
125 KVA (two) General Motors 1200 rpm

GAS ENGINE UNITS

250 KVA GE-Cooper Bessemer, 450 rpm, GS-6
750 KVA EM-Worthington, 360 rpm, DDG-8

POWER PLANT EQUIPMENT CO., INC. 39 Cortlandt St. New York, N. Y.

FAIRBANKS-MORSE DIESEL PLANT

2—120 HP F.M. Model 32E12, two cylinder, two cycle, 12" x 15" 360 RPM, engines. Direct conn. to: 96 KVA F.M. AC Alternators 3/60/240 V., with belted exciters, compressor, tanks, and switchboard.

Various Types & Sizes in Stock

ALJON ELECTRIC DIESEL CO.
904 Pacific St. Brooklyn 38, N. Y.
STerling 3-6515

STORAGE & PRESSURE TANKS

Located Mich.-Mo.-Fla., N.J. & Conn.

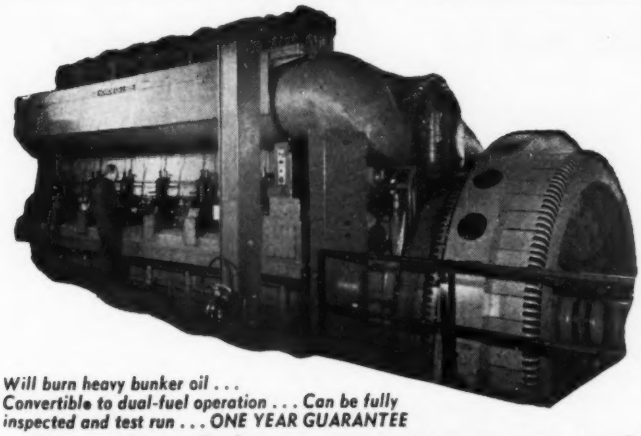
8—12,000-17,000 & 20,000 Gal. 90 Lb.
16—10,000-15,000 & 20,000 Gal. Storage
9—42,000, 120,000 & 240,000 Gal. Storage
10—10,000 Gal. Cap. RR Car Tanks

LESTAN CORP., ROSEMONT, PA.

CURRENT MODEL·· DIESEL

1980 KW NORDBERG MODEL TS-217 DIESEL UNIT

Heavy Duty • Slow Speed • Available Immediately



Will burn heavy bunker oil . . .
Convertible to dual-fuel operation . . . Can be fully inspected and test run . . . ONE YEAR GUARANTEE

ENGINE: (2800 BHP net) Nordberg, 7 cylinder, 2 cycle Diesel engine at 225 RPM, 21½" bore, 29" stroke, cylinders arranged vertical in line, solid injection.

GENERATOR: 1980 KW, 2475 KVA General Electric generator, 2400/4160/6900 volts, 3 phase, 60 cycle service at 225 RPM.

(50 cycle rating 1650 KW at 187 RPM)

UNIT AUXILIARIES AND ACCESSORIES

Complete standard engine auxiliaries and accessories including filters, strainers, pumps, gauge board, pyrometer, thermocouples, exhaust muffler, lubricating oil cooler, Young evaporative type cooler for jacket water cooling, thermostatic control valve, fuel oil day tank with transfer pump and oil meter, 2 lubricating oil storage tanks, lubricating oil transfer pump, Diesel-driven air starting unit, air tanks, air intake filter, special engine tools, all station piping, including flanges, adapters, valves, and fittings, for air intake exhaust, water, lubricating oil, fuel oil, and air. Generator and exciter control switchgear.

The unit above affords a rare opportunity to procure a complete, modern current model, heavy duty, slow speed diesel set at a great saving. It represents an offering which cannot be duplicated anywhere in the diesel market today.

Act now . . . Phone, Wire, or Write for Full Details

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A.G. SCHOONMAKER CO., INC.

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CABLE:—AGSCOMACH

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Plants and Warehouses: Jersey City, N. J. and Sausalito (S.F.), California

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AT MARION, INDIANA

5—Welded Steel Storage Tanks (closed' 10,500 gal., 11,300 gal. and 12,700 gal.

1—Steel Shell & Tube Heat Exchanger, 1000 sq. ft.

1—Roots Connersville 10x17 type WG Exhauster, 800 CFM.

FOR SALE FROM PHILA. STOCK

2—I-R Motorblowers, type FS-538; cap. 4000 CFM @ 3# Pr.

1—Byron Jackson Bronze Deep Well Turbine Pump with 20 HP motor. 150 GPM.

1—I-R #1½-RVH Bronze Centrifugal Motorpump with 20 HP motor. 200 GPM—200'.

1—Centrifugal Pump, 6" x 5", 40 HP 3/60/220 motor, 1000 GPM—88'.

PERRY EQUIPMENT CORP.

1422 N. 6th St. PHILA. 22, PA.

ELECTRICAL EQUIPMENT

REBUILT N.I.S.A. STANDARDS

AC Motors — 3 phase 60 cycle

HP	Speed	Make	Wdg.	Type & Disc.
500(3)	1800	West.	Syn. 2200 V.	PedBrgW/Exc
450	1800	AC	SC 2200 V.	AW-SB
350	1800	AC	SC 2200 V.	AW-SB
200	1800	GE	SC	K6333S TEFC
150	1800	GE	SR	M-6328 TEFC
150	720	Allis-Chal.	SR	ARHoist
150	720	West.	SC	CS
125	3600	Elliott	SC 2200 V.	9NS02
125	1200	AC	SR	ARY-BB
100	900	GE	SR	MT-S.S
100	1800	GE	SR	IM
100	725	Allis-Chal.	SR (25 cy.)	ARY-3 Brg.
100	900	GE	Syn 2200 V.	TS-DC Exciter
75	1200	Wagner	SC	24-W
75	900	West.	SR	CW-752C
75	600	GE	SR	IM
75	600	GE	SC 2200 V.	KT-558
60	1200	GE	SC	I-K
60	3600	GE	SC	K 1448B
50(3)	1200	Allis-Chal.	SR	ARY-505 BB
60	900	AC	SC 2200 V.	ARZ-TEFC
50	1800	GE	SC	IK
50	1800	FM	SR	HV-BB
50	1200	GE	SR	MT-336
50	900	GE	SC	IK
50	720	CW	SC	SC
50	600	CW	SR	SR
40	3600	GE	SC	K-405aExp.Pr.
40	1800	GE	SC	KT
40(2)	1200	Rel.&West.	SC	Fr. 115-BB
40(2)	1200	AC&Rel.	SC	TEFC-BB
40	900	West.	SR	CW
30(3)	1800	AC	SC	ARZ-TEFC
30	1200	AC	SC	ARZ-TEFC

SPECIALS

1—500 KVA Trans. West'hse Type ASL, 5% Imp. 13800/480 volts 75° Air Cooled. 2—150 KW West. M-G Sets 275 V. DC 3/60/2300 AC. 2—56RZ Falk Motoreducers 125 RPM 50 HP Class II. Hundreds other motors and electrical items in stock. Large stock new motors to 150 hp & Gearheads to 30 hp at rated discount —Freight allowed. **SEND US YOUR INQUIRIES.**

NATIONAL ELECTRIC SERVICE CO.

735 So. 4th St., St. Louis 2, Mo. Phone — Chestnut 4461

Something to TALK ABOUT

THE MONEY YOU SAVE ON EQUIPMENT GUARANTEED BY HEMPHILL ELECTRICAL ENGINEERS

This seal says so!

TRANSFORMERS—60 Cycle

Qu.	KVA	Make	Type	Ph	Voltages
1	1500	G.E.	Pyranol	3	4150x2400
1	1000	G.E.	Auto	3	4150x2400
2	750	G.E.	HT	3	4150x120/240
2	750	G.E.	H	1	4600-120/240
1	500	Kuhl.	OISC	1	4150x2400
2	400	Pitts.	OISC	1	4800/4150/2400 x240/480
3	333	Whse.	OISC	1	2400x575
1	333	G.E.	H	1	13200x220 440
2	300	G.E.	H	1	13200x440
4	200	G.E.	H	1	13200x440
1	200	G.E.	HT	3	2400x240
2	150	Pitts.	ODSC	1	240x120/240
3	50	G.E.	H	1	4800x120/240
3	50	A.C.	H	1	230x120/240
1	25	G.E.	H	1	460x120/240
1	20	G.E.	Novalux		2400 6.6 Amps
2	25	G.E.	H	1	575x115/230
	25	Nlag	OISC	1	2400x480
8	7½	Electran Air		1	460-8-40

MOTOR GENERATOR SETS

Qu.	KW	Make	Speed	DC	AC
1	1000	G.E.	514	600	2300/4150 Syn.
1	1000	Whse.	720	600	2300/4150 Syn.
1	1000	Whse.	720	275	2300/4150 Syn.
1	300	C.W.	1200	230	3-unit 2400/4150SR
1	300	G.E.	1200	230	2400/4150SR
1	200	Whse.	900	230	2300/4150 Syn.
1	150	C.W.	1200	230	440 SC
1	150	3 Unit G.E.	1200	125/250	2300 Syn.
1	150	Whse.	600	125	4150 Syn.
1	125	C.W.	1200	125	2300 S.C.
1	100	G.E.	900	250	2300 Syn.
3	60	G.E.	1200	125	208 Syn.
2	30	G.E.	1200	125	440 SC

SYNCHRONOUS MOTORS

Qu.	H.P.	Make	Speed	Type	Volts
1	300	El. Mach.	720	TEFC	2200
3	200	Whse.	720		4150
1	175	G.E.	720	ATI	2300
1	150	G.E.	720	ATI	2300
1	150	G.E.	1800	TS	220
1	150	Whse.	900	181G	220

Qu.	H.P.	Make	Speed	Volts
1	150	A.C.	360	440
1	125	El. Mach.	900	4800
1	100	G.E.	900	2200

SLIP RING MOTORS

Qu.	H.P.	Make	Speed	Type	Volts
2	500	G.E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	600	CW	440
1	200	Whse.	600	CW	440
1	200	G.E.	600	MT	440
3	150	A.C.	1800	AY RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	IM	440
1	75	G.E.	600	IM	440
1	60	G.E.	1800	MT	220

DC, 230 VOLT MOTORS

Qu.	H.P.	Make	Speed	Type
1	300	G.E.	1200	MPC
2	150	C.W.	900	WP
1	125	G.E.	1700	RC
2	75	C.W.	900	WP
1	30	C.W.	700	CM
1	35	G.E.	860	RC
1	25	Whse.	825	BK

Member of The National Industrial Service Association, Inc.

"FOR POWER"
J.L. HEMPHILL & CO.
1604 53rd STREET, NORTH BERGEN, N. J.
PHONE NEW YORK—LONGACRE 5-3227
PHONE NEW JERSEY—UNION 3-2600

POWER PLANT EQUIPMENT
SPECIAL OFFERINGS

TURBO-GENERATORS

1—20,000 KW 200# 13,200 V.
1—10,000 KW 200# 13,800 V.
1— 5,000 KW 275# 11,500 V.
1— 4,000 KW 400# 2300 V.
1— 3,000 KW 425# 13,200 V. Ext/170# Non Cond.
1— 3,000 KW 175# 550 V. Cd.
1— 1,500 KW 150# 2300 V. Cd.
1— 1,500 KW 175# 550 V. Ext.
1— 1,000 KW 250# 480 V. Ext.
1— 1,000 KW 200# 4160 V. N.C. NEW 1949.
2— 750 KW 150# 250 V. D.C.
1— 500 KW 200# 4160 V. N.C.
1— 300 KW 125# 250 V. D.C.
2— 120 KW 150# 240 V. N.C.

DIESEL GENERATORS

1—1000 KVA 2400 volts
1— 200 KW 250 V. D.C.
1— 400 KW 480 volts
1— 300 KW 2400 volts
2— 75 KW 240/480 V.

BOILERS

2—50,000# 275# (1949)
3—15,000# 275# (1945)
1—400 HP Sec. Hd. 225#
1—300 H.P. 300# (1948)
1—84" HRT 150# (1942)

DEAERTING HEATER

1—85,000# Never Used

Write or wire for additional data and prints.

A. LEE ELLIS CO., U. S. Machy. Bldg., 140 Federal St., Boston 10, Mass.

THE BUYERS MUST BE SATISFIED—ALWAYS

FOR SALE
18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
408 DONOVAN BLDG.
DETROIT 1, MICH.

MOTORS MG SETS

Qty.	HP	Make	Voltage	Speed
12	3000	West.	525/600	600 RPM
26	1500	West.	525/600	600 RPM
32	1500	Al. Ch.	525/600	675 RPM
4	1200	Al. Ch.	525/600	650 RPM
2	900	Elliott	230	300/195 RPM
3	800	West.	525/600/600/900	RPM
1	650	Cr. Wh.	230	475/720 RPM
1	500	West.	230	250/500 RPM
1	400	G.E.	230	180/360 RPM
7	400	Elliott (new)	230	400/800 RPM
5	400	West. (new)	230	375/750 RPM
2	350	Cr. Wh.	230	400/800 RPM
1	200	Cr. Wh.	230	500/750 RPM
1	200	Cr. Wh.	230	375/750 RPM

All motors designed for mill reversing service.

Smaller sizes also in stock.

Motor Generator Sets in Stock 100—2000 KW Capacity

All of above is modern late type equipment remanufactured & tested by our engineers.

Write, Wire, Phone

All guaranteed for one year

A. G. SCHOONMAKER CO., INC.
50 CHURCH STREET, NEW YORK 7, N. Y.
Plants: SAUSALITO (S.F.) CAL., JERSEY CITY, N.J.

COMPLETE DIESEL PLANT

3—Fairbanks Morse units. 805 HP—556 KW; 690 HP—473 KW; 300 HP—200 KW. Model 33-E-14. 3/60/2400 volts. New 1940. Will sell all or part. With auxiliaries. Condition excellent.

MISSISSIPPI VALLEY EQUIPMENT CO.
507 Locust St. St. Louis 1, Mo.

ELECTRICAL CABLE

- For every industrial and power application.
- Special constructions. Odd lengths.
- Large stocks on hand of high voltage, lead covered cables not ordinarily stocked by your regular suppliers.
- Cut to length. Reasonably priced.

UNIVERSAL WIRE AND CABLE CO.
2668 N. Clybourn Av., Chicago 14, Ill.

1—2000 KVA, 3-60-33000-4160Y Westinghouse type CPS self-contained substations.
1—450 KVA, 3-60-13200-115/230 V. G.E. substation.
6—Section NEW G.E. switchboard consisting 2000, 600 and 350 A. drawout air breakers.
700 & 450 HP, 180 rpm, 4160V-3-60 UNUSED Syn motors.
1—37½ KVA-240/480 V.-3-60 Cat. Diesel set.

H. BLAINE JOHNSON & ASSOCIATES
53 W. Jackson Blvd., Chicago 4, Ill.

RECTIFIERS & MG SETS

2—500 KW Westgh. 4160/2300—275 v—1200 rpm
1—150 KW G.E. 4000/23000 v—250 v—1200 rpm
2—150 KW Westgh. 2200 v—275 v—900 rpm
1—300 KW G.E. Rectifier 2300—250 v

AIR COMPRESSORS

1884 ft. CHICAGO PNEU. OCE 2300 V.
676 ft. WORTHINGTON 3/80/220/440 V.
9—JOY 445' & 512'—3—950'—220/440/2200 V.

DARIEN, 60 E. 42nd Street, New York, N.Y.

EMERGENCY GENERATORS

Diesel and Gasoline 1 to 1000 KW

RENT • BUY • SELL

MIDWEST UTILITIES POWER EQUIPMENT CORP.
1270 Augusta Boulevard, Chicago 22, Ill.
Phone: EVergiade 4-4511

O'Brien Offers—

MOTOR GENERATOR SETS

1500 KW G.E. 250 Volt 3/60/2300/360 RPM
1—1000 KW West. 250 volt Flat Compound 500 RPM 1440 H.P. West. Syn. Mtr. .8 P.F. 3/25 cycle 2300 V. A.C. & D.C. Panels
1—500 KW Crocker Wheeler CCD, 250 volt 720 RPM with 750 KVA Cr. Wh. Syn. Motor 3/60/2300 V. A.C. & D.C. Panels.
1—300 KW West. 3 wire 125/250 Volt 1200 RPM Generator (1938 year). Can furnish with suitable motor. Advise Requirement.
2—250 KW Burke 125 V. 435 KVA Syn. M.D. 3/60—any voltage
1—150 KW G.E. Type MPC—250 Volt 1200 RPM 3/60/2300/200 H.P. Syn. Motor Drive A.C. & D.C. Panels
100 KW Electro Dynamic 200 V. 3/60/220/1200 B. Brg. Sq. Cg. Sep. Excited.
1—100 KW Al. Ch. 250 V. 1200 RPM 150 HP. Syn. Mtr. 2/60 or 3/60 any voltage.
1—100 KW G.E.—C.D.—125 Volt D.C. 150 HP GE Syn. Mtr., 3/60/220/440/1200 RPM.
1—75 KW Burke 250 V. 900 RPM 113 H.P. Burke—Syn. M.D. 2 or 3 ph, any voltage.
1—62½ KW 125 volt Hertner, 1200 rpm, 100 HP Sq. Cg. 3/60/220
2—50 KW GE 500 Volt DC, 75 HP, 3/60/40/1200 RPM.
Smaller Sizes and Types—Advise Requirements

BOILERS

2—500 HP Cleaver Brooks Package 200 lb.
1—450 HP Keeler CP 160 lb. Oil
1—300 HP Keeler CP 300 lb. Oil
2—200 HP Springfield Sec. Hdr. 300 psi.
1— 80 HP Cleaver Brooks Package 125 psi.
1— 60 HP Cylcotherm Package 125 psi.

Space Needed—Priced for quick sale—3—250 KVA GE Ames Vertical 4 cylinder Uniflow engines, 3/60/240/400 rpm, 140 psi, 5 lb. back pressure. Exciters, Switchboards. Condition Excellent—Contact us to inspect at Claridge Hotel Atlantic City, N. J.

DIESEL GENERATOR SETS

1—1250 KVA Nordberg 3/60/2300/360 RPM 1940
1—375 KVA GM 8-268A, 3/60/480/1200 RPM
1—250 KVA G.M. Twin 6-71, 3/60/220/440/1200 RPM Rad. Cooled.
1—187 KVA G.M. Twin 6-71 Portable, 3/60/220/440 New
1—125 KVA Hercules. 3/60/220/440/1500 Hrs.
2— 45 KVA Chry. New 6 Cyl. 3/60/220/440.
1—200 KW G.M. Twin 6-71, 240 D.C. Rad. Cooled Elec. Start.

ELECTRIC MOTORS

Qu.	HP	Make	Type	Volts	Speed
1	1000	G.E.	K	2300	1800
1	1000	West.	CW	2300	450
1	700	West.	CW	440	1800
1	600	West.	CS	2200/4160	600
1	500	Al. Ch.	Syn.	2300	212
1	500	AC	ARX	2300	1800
1	500	West.	CS	6600/2300	514
1	450	A.C.	ANY	2300	600
1	400	West.	CW	440	514
1	400	G.E.	Syn.	2300	450
1	350	G.E.	MT18	2300	400
1	250	G.E.	IM	2300	450
2	200	G.E.	KT559	2200	1200
1	200	West.	CW	440	1800
1	200	G.E.	IM	440	600
1	125	West.	Syn. 3 brg.	550	600
2	100	G.E.	KT352	220/440	1200
1	100	G.E.	KT543	440	1800
1	50	West.	CS	440	3600
1	50	West.	CS	440	1200

EXCEPTIONAL DELIVERY
New O'Brien mfrd. Red Line dry type Transformers to 150 KVA single phase, 300 KVA, 3 phase—4800 V. Pri.—& Phase Changers to 100 KVA.

TURBO GENERATORS
Philadelphia Stock

1—2500 KVA West. Cond. New 1936. 3/60/2400—200 psi Surf. Cond.
1—1250 KVA DeLaval Non-Cond. 3/60/2300. New 1940 240 psi 50 lb. B.P.
1—938 KVA West. 3/60/2300/3600 Surf. Cond. 350/400 PSI.
1—780 KVA G.E.-Moore 3/60/2300/3600 RPM Non-Cond. 180 PSI 35 lb. B.P. New 1936.
1—187 KVA West. Non-Cond. New 1930 3/60/440 110 psi 10 lb. B.P.
1—94 KVA Worthington Non-Cond. 3/60/220 140 psi 5 lb. B.P.
1—75 KW G.E. Non-Cond. D.C. 125 volt.

AIR COMPRESSORS

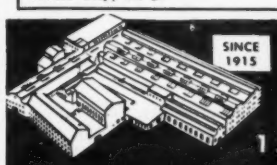
1—1600 CFM Sullivan WJ 8 Angle Cpd. 100 psi 22/13x16 belt.
1—978 CFM Sullivan 13x13x8, 45 psi.
1—900 CFM CP 100 lb. 9CP Portable Diesel Compressor, Pneu. tires.
1—528 CFM Ing. Rand 14x12, 100 psi.
1—215 CFM Penna 3A, 70 psi—V-Belt.
1—368 CFM Chi. NSB, 12x10, 100 psi.
1—371 CFM Schramm 7¼x5x4, 100 psi

OISC TRANSFORMERS

Qu.	KVA	Make	Pri. V.	Sec. V.	Phase
4	2000	West. (Sub-sta)	23000	2400 (NEW)	1
3	1000	GE	13200	2300	1
1	1100	West.	4160	440	3
3	667	Al. Ch.	33000	2300	1
3	500	West. (Dry)	33000	2300	1
3	500	West.	22000	460	1
1	500	Gregory	4160	440	3
3	500	GE	13200	2300	1
3	400	GE	2400	480	1
3	333	West. Dry	2400	480	1
3	333	Pitts.	33000	2300	1
3	333	G.E.	13800	240/480	1
3	333	(New)	2400	480	1

1—New O'Brien "Red-Line" 750 KVA OISC Transformer 13,200/13,800 v. pri., 480 v., sec., 3 ph.
3—333 KVA New O'Brien Red Line O.I.S.C. Transformers 4160 V primary 480 V secondary ea. single ph. 60 cyc.

"Everything from a Pulley to a Powerhouse"



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T. M. REGISTERED U. S. PATENT OFFICE

PHILADELPHIA'S LEADING MACHINERY DEALERS & EXPORTERS

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AFFILIATED WITH SOC EXPANSO INDUSTRIAL SOL AMERICANA LTDA RIO DE JANEIRO—BRASIL

C-O-M-P-L-E-T-E
DIESEL POWER PLANT
FOR SALE BY USER

Consists of:
3—300 H.P., 600 RPM, Buckeye DIESEL ENGINES, New in 1947.

Connected to:
3—200 KVA, .8 P.F., 3/60/440 ALTERNATORS and EXCITERS.

Also: Switchgear, Evaporative Cooler, Exhaust Heat Economizers, Electric and Gas Operated Starting Equipment. Piping and Valves included.

CAN BE SEEN IN OPERATION AT THE

GRAND RAPIDS METALCRAFT DIVISION
22 COMMERCE AVE., S.W.
GRAND RAPIDS 2, MICHIGAN

NEW MOTORS! • STOCK SHIPMENTS

ALL BALLBEARING

General Electric, Louis Allis, Reliance, Westinghouse. NEMA FRAME
Discounts from 60% to 65% Off on Motors listed below.

25 CYCLE TEFC & EXPLOSION-PROOF
(2G Label) 220-440 volts

Amt.	HP	Speed	Make	Frame
1	30	1500	Rel.	445
1	25	1500	Rel.	405
1	15	1500	L.A.	4058
1	15	1500	G.E. (open)	404
3	10	1500	L.A.	364
3	5	1500	L.A.	284
1	5	1500	L.A. I-D	284

1/60/115-230 (1-D Label)

4	3	1800	L.A.	254
1	1½	1800	L.A.	225
1	1½	1200	G.E.	225
6	1	1800	L.A.	224

1/60/115/230 OPEN DRIP-PROOF

26	1	1800	L.A.	204
7	1	1800	Std. D.	203

2/60/220-440 OPEN DRIP-PROOF

1	7½	900	L.A.	326
2	5	1200	L.A.	284
3	1½	1200	L.A.	224
4	1	3600	L.A.	163
2	1	1800	L.A.	203

3/60/550—OPEN DRIP-PROOF

1	100	3600	G.E.	447S
13	40	3600	Rel.	404S
1	25	3600	G.E.	364S
5	5	3600	L.A. XP	225

NEW MOTOR STARTERS

9—Size 3 Allen-Bradley, XP-2G Label Bul. 709
1—Size 3 Whse. Combination, Circuit breaker, Nema 1, 3/60/440
21—Size 2 G.E. combination fusible, 60 & 100 amp, 3/60/220
100—Size 1 NEW Whse. life line 3/60/220

3/60/220 GEARMOTORS

3—10 HP, 55 RPM, Whse. FR. 324, Parallel Shaft Output
17—NEW Cleveland right angle worm gear reducers rated 5 HP—1150 RPM, 7.5 HP—1750 RPM, 6-1 Ration, Series 215—50 RT Class 1

230 V DC

1	10	1200	Whse.	8K63
1	7½	1200	Elec. Dy.	324

10,000 Other Motors in Stock
FHP Thru 1000 HP, New and Rebuilt

BENSON-WILIMZIG, INC.

1708 North 8th Street **Garfield 4290** **St. Louis 6, Missouri**

PHONE — WIRE — OR WRITE

MOTORS • GENERATORS • TRANSFORMERS

N.E.M.A. FRAME MOTORS

2—10 HP A.C. ARX-324 1800
1—10 HP West. CS-324 1800
1—10 HP F.M. FW-326 1170
1—15 HP G.E. K 326 1800
1—15 HP C.W. SC-A365 1170
1—20 HP L.A. X-Proof 365 1800
1—20 HP West. CS-W364 1750
1—20 HP West. CS 365 1170
2—20 HP West. CS-404 1165
1—25 HP G.E. TEFC K365 1760
1—25 HP West. CS-365 1760
1—25 HP U.S. SC-364 1800
1—25 HP G.E. TEFC KG405 1170
1—25 HP G.E. K404 1170
1—25 HP G.E. K-405 900
1—30 HP Delco TEFC-405 1745
1—40 HP West. CS-404 1800
1—50 HP Ideal TEFCBB 1800
1—50 HP G.E. K-504 1200
1—75 HP West. CS 1200
1—100 American E3 3460

1—350 KW General Electric Generators Type MPC, 250 Volt DC, 720 RPM Single Bearing Machines.

25 CYCLE MOTOR SPECIALS

1— 40 HP Reliance TEFC BB 3/25/220/440/1500 RPM.
1— 50 HP Fairbanks Morse BB 3/25/220/440/750 RPM.
1—100 HP Gen. Elect. Type KT 553 3/25/440/1445 RPM.
1—100 HP Gen Elect. Type KT 559S Ball Bearing 3/25/440/1465 RPM.
2—150 HP Gen. Elect. Type KT565 TEFC BB—3/25/440/750 RPM.

MOTORS

60-50-25 Cycle in Stock—All Sizes. Slipring—Squirrel Cage—Synchronous. All types of Control Equipment.

100 HP Gen. Electric Type I form K 3/60/2300/600 RPM.
100 HP Gen. Electric Type KT 356 3/60/2200/900 RPM.
125 HP Gen. Electric Type I form K 3/60/440/720 RPM.
125 HP G. E. Type KT 3/60/2300/1200 RPM.
150 HP G. E. Type KT 3/60/440/500 RPM.
150 HP Gen. Electric Type I form K 3/60/2300/900 RPM.

400 HP GEAR REDUCER

1—400 HP Nutall (Westinghouse) Type LMR-25 Single Helical Heavy Duty Reducer—6-1 Ratio at 900 RPM with High Speed Shaft Extension for Brake.

400 HP SYNCH. MOTOR

1—400 HP Westinghouse Synchronous Motor. 3/60/2300/900 RPM. Unity P.F. with direct connected exciter—Late Type.

55" LIFTING MAGNET

1—55" Cutler Hammer Magnet 250 Volts DC. Excellent Condition.

125 VOLT DC MOTOR

1—100 HP Crocker Wheeler 125 Volt DC 850 RPM Ball Bearing

DC CIRCUIT BREAKERS

1—1000 AMP. Condit. 2 Pole
1—1600 AMP. Condit. 2 Pole
1—1600 AMP. Westinghouse 2 Pole
1—3000 AMP. Westinghouse 2 Pole

TRANSFORMERS

1—750 KVA Niagara New. Outdoor 3/60/2400/208Y/120.
3—500 KVA Westinghouse Type SL. 1/60/33000/2400/4160Y—New 1947.
3—333 KVA Westinghouse O.I.S.C. 1/60/4800/480.
1—75 KVA Gen. Elect. Dry Type 1/60/480—240.
6—50 KVA Niagara New Dry Type 1/60/240/480—120/240.
1—20 KVA Gen. Elect. Dry Type 1/60/480—120.

ERIE ELECTRIC CO., INC. 124 CHURCH ST. BUFFALO, N. Y. CL. 4758

Anything in ELECTRICAL EQUIPMENT

PARTIAL STOCK LIST — SEND US YOUR INQUIRIES

D.C. MAGNETIC STARTERS
230 Volts — New

90—15 HP Ward-Leonard, Type 17125

GREATLY REDUCED PRICES
NEW MOTORS, 220/440/3/60—Ball Bearing

Q	HP	Make	RPM	Type
26	½	Reuland	1200	ML
15	¾	Reuland	1800	MLE*
21	¾	Reuland	3600	ML*
7	¾	Reuland	3600	MLE
15	1	Reuland	900	ML
18	1	Reuland	3600	MLE*
35	1½	Reuland	1800	ML*
10	1½	Reuland	1800	ML

* Total Enclosed

MOTOR GENERATOR SETS

Q	KW	Make	RPM	DC	AC
1	250	C.W.	1200	250	2300
1	150	Al.Ch.	1200	250	2300/440/220
1	150	W.H.	1200	250	2300
1	150	G.E.	1200	250	2300
1	90	G.E.	1200	125	440/220
2	50	G.E.	1200	125	440/220

D.C. MOTORS, VARIABLE SPEED

Q	HP	Make	RPM	Volts
2	7½	W.H.	400/1600	230
1	10	W.H.	400/1600	230
5	15	W.H.	500/1500	230
2	15	W.H.	550/1650	230

D.C. GENERATORS

2—300 KW, W.H. 125 Volts—750 RPM
1—100 KW, W.H. 125 Volts—900 RPM

SLIP RING MOTORS

1—Al. Ch. 400 HP, 505 RPM, 2300 V Serial #110,844
1—Al. Ch. 400 HP, 1300 RPM, 2300 V Serial #941CH146D
1—W.H. 100 HP, 720 RPM, 440 V

MOTORS, GEAR HEAD, A.C.

7½ HP W.H. TEFC, 3/60/220/440-580 RPM-RB
20 HP Link Belt, Size DM70, 3/60/220/440 74 RPM-RB
20 HP W.H. TEFC, 3/60/220/440-194 RPM-RB
40 HP G.E. TEFC, 3/60/220/440-561 RPM-RB

BUCKEYE *Trading Corporation*

LARGEST STOCK IN MIDWEST

1019 PAPIN STREET CHESTNUT 3110 ST. LOUIS 2, MISSOURI

BOILER FEED PUMPS

1—Lecourtenay 675 G.P.M., Type 4M, 8B, 5 stage, 1100 Ft. Hd.
1—Worth. 740 G.P.M., type WCS-2, 5", 2250 Ft. Hd.
1—Worth. 700 G.P.M., type UNS-1, 6 stage, 6", 1550 Ft. Hd.
2—I. R. 200 G.P.M., 2", 1375 Ft. Hd.

Pumps above are mounted on bases for motor or turbine drive.
We have about 200 various size cent. pumps on hand, turbine, motor, and gasoline driven. Send us your inq.

DALTON SUPPLY CO.
2829 Cedar St. Phila. 34, Pa.

USED 35 TON BRIDGE CRANE

75' span with 5 ton aux, 25' lift. Cab type 3/60/220 V. A.C.—used approx. 2 yrs. Mfg. Northern—*excellent condition.*

DAVE GORDON STEEL PRODUCTS, INC.
2411 35th St. Tampa, Fla.
P.O. Box 5033 Ph. 4-2367

FOR SALE

MODERN 1000 KW Turbo-Generator

in excellent Condition

Non-Condensing, Steel case 80# back pressure .8 P.F., 3 phase, 60 cycle, 4150/2300 volts, alternating current, complete with accessories, switchboard, oil circuit breaker and direct connected exciter. Only operated alternately for six years. Ideal for Chemical, Rubber, Petroleum. Textile, Pulp and Paper, and Sugar Refining Industries.

NEWMAN & COMPANY, INC.
6101 Tacony St. Philadelphia 24, Pa.

MOTORS—M. G. SETS—TRANSFORMERS

ENGINEERED AND REBUILT BY EXPERTS IN OUR OWN PLANT

SYNCHRONOUS MOTORS

Qu.	H.P.	Make	P.F.	Volts	R.P.M.
1	6000	G. E.	100	2300	90
1	3000	Whse.	80	4800/2400	720
2	2100	G. E.	100	2300	360
2	1750	G. E.	100	2300	3600
1	750	G. E.	80	2300	450
1	600	G. E.	100	440	360
1	700	G. E.	80	2300	720
1	250	G. E.	100	2300	514
1	200	Whse.	80	440	1200
1	187	G. E.	80	440	720
1	150	G. E.	100	2200	900
1	150	G. E.	100	550	600
1	150	G. E.	80	220/440	450
2	135	G. E.	80	4000/2200	1200
3	125	El. Mchy.	100	4800/2400	900
1	125	G. E.	80	2200	900
2	100	Whse.	80	440	1800
1	100	Ideal	80	440	900
2	100	G. E.	80	440	600

With these we can supply—Manual, Semi on full magnetic reduced or full voltage control.

SQUIRREL CAGE MOTORS

3-Phase — 60 Cycle

Qu.	H.P.	Make	Type	Volts	R.P.M.
1	400	Cont.	NZ-806	2300	1200
2	400	G. E.	I-K	2200	v514
1	400	G. E.	KT-412	2200	450
1	300	Whse.	CS-890	2300	1780
1	200	Whse.	CS-873-C	2200	1200
1	200	Al. Ch.	ARY	440	600
1	125	Al. Ch.	AR	2200	1750
1	125	Al. Ch.	AR	2300	514
1	125	C. W.	126-Q	440	430
2	100	Whse.	CS-663-C	440	1750
1	100	Al. Ch.	AR	550	720
1	100	Whse.	CS-938	200	514
1	100	F. M.	H-241	440	450
2	75	Al. Ch.	AR	2200	1705
1	73	G. E.	I-K	440	600
1	75	Al. Ch.	AR	2200	720

Special—1 (new) G. E. Vertical KF-574, 2200-Volt 580 R.P.M. enclosed hollow shaft.

MOTOR GENERATOR SETS

Qu.	KW	Make	RPM	Volts DC	Volts AC
1 (3-U)	2400	Whse.	720	600	4800/2400
1	1500	G. E.	600	600	4160/2300
3	1000	Whse.	514	600	11,000/6600
2	1000	G. E.	514	600	11,000/6600
1	750	Whse.	900	250	4160/2300
2	500	C. W.	720	575	2300/440
1 (3-U)	500	Whse.	1200	125/250	440
1	400	C. W.	1200	125/250	440
2	250	Whse.	1200	125/250	2300/440
1	200	Whse.	1200	275	4000/2300
1	200	Whse.	1200	125/250	4000/2300
1	155	G. E.	720	250	2300/440
2	150	Whse.	1200	125/250	440
1	100	Delco	1200	125/250	440/220
1	100	Ridgeway	1200	275	4000/2300
1	100	C. W.	1200	125	440/220
1	85	C. W.	1200	250	440/220
1	75	Al. Ch.	900	250	2300
1	75	Whse.	900	240	2300
1	25	Ideal	1750	125	440/220
1	25	Al. Ch.	1200	250	440/220
3	20	Al. Ch.	1200	250	440/220
2	15	Al. Ch.	1200	250	440/220

We can furnish any of these sets with D. C. panels, A.C. starting equipment, exciter sets and other accessories.

Motor Generator Sets of modern design, complete with control—still on their original foundations—available for immediate shipment.
(3)—G. E. 1500-KW, 250-VDC, 514 R.P.M., cpd., interpole, pole face windings, 2100-HP syn. motors, .8-PF, 13-200-V, 3-p, 60-cy. will reconnect to 6600-V. or 4160-V.

TRANSFORMERS (Power)

Outdoor — Oil Cooled

Qu.	KVA	Make	Type	Phase	Voltage
3	250	Packard	A	1	13200-2200
3	150	Packard	A	1	2300-230/460

3—833-KVA Westinghouse O.I.S.C. transformers, type S, one phase, 60 cycle, still on original foundation, primary 66,000 Volts with (4) 2½% taps below secondary 2300/4160-Y. Can ship immediately from location.

SLIP RING MOTORS — CONSTANT DUTY

3-Phase — 60 Cycle

Qu.	H.P.	Make	Type	Volts	R.P.M.
1	1800	G. E.	MT 498	2300	357
1	1200	G. E.	MT 26	2200	277
2	1000	Al. Ch	ANY	2200	235
1	800	G. E.	MT	2200	440
1	600	G. E.	MT 20	2300	360
1	500	Al. Ch.	ANY	2200	514
2	500	G. E.	I-16-M	2300	450
1	400	G. E.	MT 412	2200	440
1	250	Whse.	CW 937	440	1200
1	250	Al. Ch.	ANY	440	720
1	250	G. E.	MT 414	2200	300
1	125	Whse.	CW 870	2200	900
1	100	Whse.	CW 766	440	1200
1	100	F. M.	H 20 C	440	900
2	100	G. E.	I-15A-M	2300	514

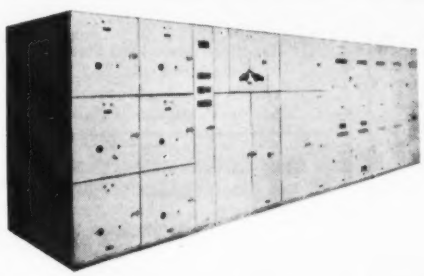
DIRECT CURRENT MOTORS

Qu.	H.P.	Make	Type	R.P.M.
1•••	3000	Whse.	Encl. (Rev.)	600
1•••	2400	Whse.	Encl. (Rev.)	600
4•••	1500	Whse	Encl. (Rev.)	600
4•••	1200	Whse.	Encl. (Rev.)	600
4•••	800	Whse.	Encl. (Rev.)	600
10•••	700	Whse.	Mill	285/720
1	350	G. E.	CD-169	1150
1••	250	G. E.	MPC-6	325/975
1••	200/250	El. Dy	Size 22	400/1200
1••	200	Whse.	Mill	300/1200
1••	200/250	G. E.	MPC	300/900
1••	180	G. E.	MPC	400
1•••	125	Whse.	SK-190	600
1••	90/160	G. E.	MPC	625/1125
2	125	Whse.	SK-181	575/850
1	75	G. E.	CD-133	500/1000
1	60	El. Dy.	25-8	450/900
1	50	G. E.	RF-16	300/900
1	50	Whse.	SK	250/1000

All above are 230-VDC except where marked •••
•••—Pedestal bearing mill type 525/600-VDC.
••—Pedestal Bearing 230-VDC.

T. B. MAC CABE COMPANY

4314 CLARISSA STREET — Phone DAvenport 4-8300 — PHILADELPHIA 40, PENNA.



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SAVE UP TO 50%

WITH THIS MODERN ROLLER SMITH SWITCHGEAR

3 POLE 600 VOLT AC OR 750 V DC
13— 600 AMP BREAKERS
3—1200 AMP BREAKERS
2—3000 AMP BREAKERS
METERING CUBICLE

AVAILABLE FOR INSPECTION — CAN BE SHIPPED IMMEDIATELY
WILL MODIFY TO MEET YOUR SPECIFICATIONS
OVERALL SIZE — 24'-10" x 7'-6" x 2'-6"

TRANSFORMERS

3 PHASE—60 CY.

1—2500 KVA 11500 to 480 Volt 3 Ph. 60 Cy. General Elec.
1—1800 KVA 6600 to 440 Volt 3 Ph. 60 Cy. General Elec.

1 PHASE—60 CY.

3—3333 KVA 66000 to 33000 & 132000 V 1 Ph. 60 Cy. Westinghouse

2—1000 KVA 13200-2300 v. 1 ph. 60 cy. Gen. Elec.
4—200 KVA 33000-2300/4600 v. 1 ph. 60 cy. Pittsburg
10—100 KVA 33000-2300/4600 v. 1 ph. 60 cy. Pittsburg
3—100 KVA 33000-2300/4600 v. 1 ph. 60 cy. Allis-Ch.

TURBO-GENERATORS

CONDENSING

1—6250 KVA 5000 KW 3600 RPM Allis Chalmers 200 lbs. 100° SH. Will operate 275 lbs. 6150 TT without change. Generator 3/60/11500. Can be changed to 2400/4160. Complete auxiliaries. Can be operated for inspection. Checked by factory engineer in Sept. 1951—no repairs required.

1—1567 KVA 1250 kw 3600 RPM Allis-Chalmers 150 lbs. Will operate 200 lbs. 450° TT without change. Generator 3/60/2300. Complete auxiliaries.

1—1250 KVA 1000 kw 3600 RPM Westinghouse 185 lbs. 100° SH 3/60/2300. Completely reworked, generator has new winding. Complete auxiliaries.

1—937 KVA 750 kw 3600 RPM Gen. Elec. 150 lbs. Generator 3/60/2300.

NON-CONDENSING

1—1875 KVA 1500 KW 3600 RPM General Electric 140 lbs. turbine with type ATB 3/60/2300, 80 p.f., Synchronous Generator.

1—1250 KVA 1000 KW 3600 rpm General Electric 140 lbs. turbine with type ATB Form T 3/60/2100, 80 pf, Synchronous Generator.

1—625 KVA 500 kw 3600 rpm General Electric 175 lbs. Single stage turbine with type ATB form T 3/60/2300, 8 pt. Synchronous Generator.

1—187½ KVA 150 kw Westinghouse geared 7200/900 rpm 150 lbs. 100° SH. Generator 3/60/240.

1—125 KVA 100 kw Westinghouse geared 7200/900 rpm 150 lbs. 3/60/240.

TAMPA ARMATURE WORKS INC.

401 S.MORGAN ST. — TAMPA, FLORIDA — PHONE 2-1966

SLIP RING MOTORS 3-Ph., 60 Cy.

HP	Volts	Make	Speed
600	2200	Whse.	450
500	440/220	Whse.	720
500	2300/4000	G.E.	900
450	440	Whse.	514
300	440	G.E. (hoist)	600
300	2200/440	Whse. (new)	600
300	2200	G.E.	360
300	440	Whse.	3600
250	4000/2300	G.E.	450
250	440/220	Whse.	600
250	550/440	G.E.	1200
250	440	G.E.	600
200	440/220	Whse.	514
200	440	G.E.	450
188	4000/2300	G.E.	1800
150 (2)	440/220	G.E.	720
150	2200/440	G.E.	600
150	550/220	G.E.	720
145	4000/2300	G.E.	1800
135	440/220	G.E. (hoist)	600
125	440/220	G.E.	900
125	550/440	G.E.	1200
125	2200	G.E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

HP	Volts	Make	Type	RPM
400	2200/440	G.E.	ATI	720
350	440/220	El. Mchy.	Syn.	1200
350	440/220	Whse.	HR	900
300	2300/400	G.E.	TS	720
300	2300/440	G.E.	TS	720
250	440/220	Whse.	HR	277
250	2200/440	G.E.	TS	1200
250	440/220	G.E.	ATI	600
240	2300/440	G.E.	ATI	720
225	440/220	Whse.	HR	360
200	4150/2300	Whse.	G	1800
125	440/220	Whse.	HR	400
120	440/220	G.E.	ATI	900
110	440/220	G.E.	TS	257

SQUIRREL CAGE MOTORS

HP	Volts	Make	Type	Speed
600	2200	G.E.	FT	3600
500	2200/4000	Elliot	SC	1800
400	2200/400	Whse.	CS	720
350	2200	G.E.	KT	1200
350	2300	G.E.	KT	1200
300	2200	L. Allis	FS	1800
300	2200	G.E.	FT	3600
250	2200/440	G.E.	IK	720
225 (2)	2200/440	G.E.	KT	1200
200	2200/440	G.E.	K	1200
200	440	G.E.	IK	720
200	440	G.E.	IK	514
200	440/220	G.E.	KT	1800
200	2200/440	G.E.	IK	600
150	2200	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440	Multi sp.	KT	1800/600
150	440/220	G.E.	IK	450
150	440/220	G.E.	KT	720
150	440/220	Howell	R. Brg.	1800
150	440/2200	G.E.	IK	514
150	2200/440	G.E.	KT	600
125	440/220	G.E.	KT(vert.)	1200
100	2200/440	G.E.	K	1200
100	220/440	G.E.	K-TEFC	720
60 (2)	2200	Whse.	CS X-proof	1800
50 (2)	440/220	Whse.	CS-TEFC	1800
50	220	Al. Chal.	ARZZ X-proof	600/1200

A. C. GENERATORS

1—320 kva, 660 rpm, 2300/440/220 V., G.E.
1—275 kva, 1200 rpm, 440 V., G.E.
1—250 kva, 720 rpm, 2300/440 V., G.E.
1—225 kva, 600 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm, 2200/440 V., GE. (Ball brg.)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp., GG E., 3 pole, 600 v
2—1600 amp. ITE 3 pole, 600 v

D. C. MOTORS

HP	Volts	Make	Type	Speed
250	230 (2 new)	Cr. Wh.	CMC	1800
250	230 (2)	G.E.	CD	1750
150	230	Whse.	SK	850
100	230	Cr. Wh.	CMC	625
90	230	G.E.	CD	1750
80	230	G.E.	RC	600
50	230	Rel.	T	400/1200

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	2200	Syn.	250
175	G.E.	220/440	Syn.	230
150	Whse.	440	sq. ca.	250
100	Al. Ch.	2200/440	sq. ca.	240/120
100	Whse.	440/220	sq. ca.	125
75	G.E.	2200/440	syn.	125
65	G.E.	2200/440	sq. ca.	250
65	G.E.	2200/440	sq. ca.	125
60	G.E.	440/220	sq. ca.	250/125
45	G.E.	440/220	sq. ca.	250
40	G.E.	440/220	sq. ca.	250/125

TRANSFORMERS 60 CY.

1—600 kva, Standard, 13,800-2300 V., 3 ph.
3—200 kva, G.E., 11000—2300 V.
3—200 kva, G.E., 4150—480/240 V.
3—150 kva, G.E., 33000—2300/4600 V.
3—150 kva, Al. Chal., 2400—240/480 V.
3—150 kva, Al. Chal., 2400-240/120 V.
3—100 kva, Whse., 2400-240/480 V.
6—100 kva, Whse., 2400—120/240 V.
5—100 kva, G.E., 4150—120/240 V.
2—100 kva, Whse., 2400—120/55 V.
3— 75 kva, Whse., 2400—240/480 V.
1— 75 kva, Moloney, 4150—240 V.
3— 50 kva, Whse., 440—220/110 V.,
6— 50 kva, G.E., 2400—120/240 V.
11—50 kva, Whse., 2300-110/220 V., dry

STEPHEN HALL & CO.

HARRY J. RICE PRES.

458 SEVENTH ST. HOBOKEN, N. J.

LAND'S 44th YEAR

MOTORS & GENERATORS, etc.

1 YEAR GUARANTEE

125 VOLT DC GENERATORS

KW	Make	Speed
150	Westg. (2)	1200
100	Cr. Wh.	1200
100	E.M.	1200
100	G. E. (2)	900
100	Westg.	1200
100	Westg. (2)	900
75	G. E. (2)	1200
60	Westg.	1750
50	Cr. Wh.	1160
50	G. E.	1150
50	Westg. (2)	1150
40	G. E. 3-unit	1150

PLUS 40 additionnal units
½ to 40 KW

250 VOLT DC GENERATORS

KW	Make	Speed
2000	G. E.	NEW
1150	G. E.	NEW
1000	A-C	720
250	Cr. Wh.	1200
200	G. E.	1200
150	Westg.	900
125	G. E. (3)	1200
125	E. D.	1750
100	Delco (4)	1150
75	Westg.	900
75	Cr. Wh.	1150
60	N. W.	1150
40	Rel.	1750
40	G. E. 3-Unit	1150
25	G. E.	1200
17	A-C	1750
15	Star	1750
10	G. E.	1150

PLUS 15 additional units
½ KW to 7½ KW

SLIPRING MOTORS

HP	Make	Speed
600	C. W.	514
500	G. E.	600
500	G. E. (2)	450
450	G. E. (2)	880
350	Westg.	435
300	Westg.	1150
250	G. E.	600
200	G. E.	1750
200	Westg.	600

Partial Listing Only!

Please Send Us Your Inquiries

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Established 1910

156 Grand Street, New York 13, N. Y.
CAnal 6-6976

STEAM POWER PLANT

5—714 HP Combustion Engineering WATER TUBE BOILERS, with Ebasco Superheaters, Sturtevant High Pressure Economizers, Green Chain Grate Stokers, Hagan Combustion Controls, Copes Feed Water Regulators, Clarage Forced Draft Fans, Sturtevant Induced Draft Fans, Smoke Stacks. Good for 250# pressure by Hartford.
1—705 HP Stirling 4 drum Boiler with B&W Superheater, Green Chain Grate Stoker, Sturtevant Economizers, Sturtevant Induced Draft Fan, with Smoke Stack. Good for 250# pressure by Hartford.
2—6000 HP Webster Water Heaters.
1—McClain Pivoted Bucket Conveyor System for handling coal and ashes. Approximately 300' long.
6—Steel Coal Bunkers, 80 tons each.
1—30" Wheeler Single Stage Circulating Pump, 30,000 GPM direct connected to 300 HP Allis-Chalmers Motor, 3/25/440, 360 RPM. (Has extra impeller for 15,000 GPM)
1—4"x6" Dayton-Dowd Centrifugal Pump direct connected to 125 HP General Electric-Curtis Steam turbine.
1—100 KW General Electric 125 Volt DC Generator direct connected to a General Electric-Curtis Steam Turbine, 2-stage with reduction gear, Type SO, 3000 to 1200 RPM.
1—Type 1A-60 Wheeler Turbo Air Pump direct connected to 75 HP General Electric-Curtis 2-Stage Steam Turbine, 1750 RPM.
1—6" Wheeler Centrifugal Condensate Pump direct connected to a 20 HP General Electric-Curtis 2-Stage Steam Turbine, 1800 RPM.
1—Combination Circulating Pump and Condensate Pump driven by 190 HP General Electric single Stage Steam Turbine through a Westinghouse Reduction Gear, 3500 to 700 RPM.
1—2" 2-stage LeCourtney Centrifugal Pump, 200 GPM 650' Heat at 3700 RPM direct connected to 53 HP Westinghouse Steam Turbine.
1—3000 KVA General Electric Synchronous Converter, Type HCC, 6 phase, 25 cycle, 250 RPM, 600 Volts DC with 1—3150 KVA General Electric Transformer, 3 phase, 25 cycle, 6600/13200-445 Volts with starting panel and all instruments.
1—1000 KVA General Electric Synchronous Converter, Type HCC, 6 phase, 25 cycle, 750 RPM, 600 Volts DC with 1-1050 KVA General Electric Transformer, 3 phase, 25 cycle, 13200/445 volts with starting panel and instruments.
1—500 KW Westinghouse Synchronous Converter, 6 phase, 60 cycle, 1200 RPM, 600 Volts DC with starting panel and instruments.
1—4000 KVA Westinghouse Transformer, 3 phase, 25 cycle, 13200/6600 volts.
7—700 KVA Westinghouse Transformers, single phase, 25 cycle, 7620/6600 volts to 13200 volts.
1—Kennecott Pressure Type Industrial Water Filter.
1—50-Ton Electric Traveling Crane—55'5½" Span.

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IMMEDIATE DELIVERY

COMPLETE 1000 KW

Diesel-Electric Generating Plant.

Consisting of 4—250 KW Fairbanks-Morse engines with direct connected 2300 V generators. Includes switchboard, station service transformers, fuel storage tanks (20,000 gal. capacity), transfer pump and all other accessories. If interested, contact:

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NEW CHGO. PNEU. YCM-ELEC. AIR COMPRESSORS FOR RENT

488 FT. 674 FT. 780 FT.
950 FT. 1317 FT. 1663 FT.
MOTORS 220-440 or 2300 VOLT

STANHOPE, 60 E. 42nd St., N. Y., N. Y.

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One 200 h.p. B. & W. Type H-3 Sterling water tube boiler. Price $10.00 per h.p. as is where it is. Located within twenty feet of railroad siding.

One 24 x 48 Hamilton-Corliss steam engine. Diameter fly wheel 15 ft.—Face 42 in. Price $2000.00 as is where it is.

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TURBINE GENERATOR UNITS

3 Phase 60 Cycle

32,500 KVA G.E. Cond. 250 lbs. 12000/13200 volts.
12,500 KVA A.C. Cond. 250 lbs. 2400 volts.
7,500 KVA West. Cond. 170 lbs. 2400 volts.
6,250 KVA G.E. Cond. 175 lbs. 2400 volts.
5,000 KVA G.E. Non-cond. Extraction 600 lbs.-125 lbs. extr. 50 lbs. exh. 13800 volts.
5,000 KVA G.E. Cond. 400 lbs. 2400/4160 volts.
2,500 KVA West. Cond. 200/400 lbs. 2400 volts.
1,875 KVA G.E. Cond. 225 lbs. 480 volts.
1,563 KVA G.E. Cond. 150 lbs.-15 lbs. extr. 480 volts.
1,250 KVA West. (2) Cond. Extraction 250 lbs.-125 lbs. extr. 480 volts.
1,250 KVA A.C. Cond. Extraction 300 lbs.-25 lbs. extr. 240/480 volts.
938 KVA Terry Cond. Extraction 250 lbs.-45 lbs. extr. 480 volts.
938 KVA G.E. (2) Non-cond. 150 lbs.-20 lbs. exh. 480 volts.
625 KVA G.E. Non-cond. 300 lbs.-5 lbs. exh. 480 volts.
625 KVA West. Cond. Extraction 200 lbs.-20 lbs. extr. 480 volts.
250 KVA G.E. Cond. 150 lbs. 480 volts.
187 KVA West. Non-cond. 150 lbs.-15 lbs. exh. 480 volts.
150 KVA G.E. (2) Non-cond. 150 lbs.-7 lbs. exh. 240 volts.

STEAM BOILERS

150,000 lbs. per hr. (3) B.&W., 250 lbs. stoker coal.
50,000 lbs. per hr. B.&W., 450 lbs. pulv coal.
25,000 lbs. per hr. B.&W., 400 lbs. stoker coal.
15,000 lbs. per hr. B.&W., 200 lbs. oil fired.
10,000 lbs. per hr. Union., 160 lbs. oil fired.

DIESEL GENERATOR UNITS

3 Phase 60 Cycle

1,250 KVA Nordberg, 2400 volts 257 RPM.
875 KVA Worthington, 2400 volts 327 RPM.
650 KVA Superior, 2400 volts 327 RPM.
625 KVA Cooper-Bessemer (New), 480 volts 600 RPM.
500 KVA (2) Fairbanks Morse, 2400 volts 400 RPM.
425 KVA Fairbanks Morse, 2400 volts 400 RPM.
400 KVA (3) General Motors, 480 volts 1200 RPM.
375 KVA (3) Worthington, 240 volts 327 RPM.
375 KVA General Motors, 480 volts 1200 RPM.
350 KVA (2) Fairbanks Morse, 2400 volts 300 RPM.
312 KVA Superior, 480 volts 360 RPM.
250 KVA Worthington, 240 volts 327 RPM.
219 KVA (2) Ingersoll-Rand, 2400 volts 600 RPM.
150 KVA Fairbanks Morse, 240 volts 360 RPM.
150 KVA Worthington, 240 volts 600 RPM.
125 KVA Hercules, 440/220/127 volts, 1800 RPM.
112 KVA (2) Cooper-Bessemer, 2400 volts 450 RPM.
75 KVA Winton (gasoline) 240/480/2400 volts 1200 RPM.
62 KVA International Harvester, 240 volts 1200 RPM.
37 KVA General Motors, 240 volts 1200 RPM.

UNIFLOW GENERATOR UNITS

3 Phase 60 Cycle

770 KVA Skinner horizontal, 150 lbs. 2400 volts.
750 KVA Ames vertical, 150-175 lbs. 240/480/2300/4160 volts.
500 KVA Skinner horizontal, 150 lbs. 240 volts.
375 KVA (2) Skinner horizontal, 150 lbs. 240/480 volts.
312 KVA Skinner horizontal, 150 lbs. 240 volts.
250 KVA Ames vertical, 150 lbs. 480 volts.
210 KVA Skinner horizontal, 150 lbs. 240 volts.
156 KVA Skinner horizontal, 150 lbs. 240 volts.

MOTOR GENERATOR SETS

3 Phase 60 Cycle

2,000 KW A.C. 2300 volts AC—250 volts DC, 720 RPM.
500 KW (2) West. 2300/4160 volts AC—250 volts DC, 1200 RPM.
300 KW G.E. 2300 volts AC—250 volts DC, 1200 RPM.
200 KW (3) West. 2300/4000 volts AC—250 volts DC, 600 RPM.
150 KW G.E. 2300/4000 volts AC—250 volts DC, 1200 RPM.
100 KW West. 2300 volts AC—250 volts DC, 900 RPM.

ROTARY CONVERTERS

3 Phase 60 Cycle

3,250 KW G.E. 13800 volts AC—250 volts DC.
1,500 KW (2) West. 13200 volts AC—250 volts DC.
500 KW West. 2300 volts AC—250 volts DC.
300 KW A.C. 13200 volts AC—250 volts DC.
150 KW (3) West. 6600/2300 volts AC—250 volts DC.

TRANSFORMERS

60 Cycle

10,000 KVA (1) A.C. 3 ph., 12000-2400/4160 volts.
3,500 KVA (1) West. 3 ph., 33000-13800 volts.
3,333 KVA (3) G.E. (New) 1 ph., 11000/33000-7200/12470/2400/4160 volts.
3,000 KVA (1) Stand. 3 ph., 33000-4160 volts.
2,125 KVA (3) G.E. 1 ph., 13200-2300/4000 volts.
1,250 KVA (3) A.C. 1 ph., 44000/11500—460 volts.
800 KVA (3) Wgnr. 3 ph., 2400/4160-480 volts.
600 KVA (3) G.E. 1 ph., 22000/11000-2300/4000 volts.
500 KVA (1) West. 3 ph., 2400-480 volts.
400 KVA (3) G.E. 1 ph., 2300—230/460 volts.
300 KVA (3) G.E. 3 ph., 6900-2400/4160 volts.
250 KVA (3) G.E. 1 ph., 2300/4000-115/230 volts.
167 KVA (1) G.E. (New Spirakore) 1 ph., 2400—120/240 volts.
100 KVA (3) Pgh. 1 ph., 7200/12470-120/240 volts.
25 KVA (3) G.E. 1 ph., 2300-230/460 volts.

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INTERNATIONAL POWER MACHINERY CO.

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750 HP B&W Sect. Header WT Boilers
150 & 250 HP Self-contained Boilers
750 KVA GE Gen. D/C N.R. Corl. Engine
150 KVA F-M Full Diesel Eng. Gent. Set
10 Ton AC Motors O.E.T. Crane—complete
2700 HP Deariating Feed Water Heater
1250 HP Marine Diesel Engines
6' x 50' Rotary Steam Dryer
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STEAM — ELECTRIC — HYDRO — DIESEL

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TYPE H STERLING BOILER

Class H-3—225#, 18000# per hour, complete with Oil Burners, pump sets, #6 oil, automatic controls, ship in 1 piece, used 3 months.

Also, 500, 750 and 1000 and 2000 H.P. forged steel, Sectional header straight tube water tube boilers. Non condensing turbo generators up to 1500 kw.

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Murray Hill 2-8562-63-64

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- **FIVE FAIRBANKS MORSE MOTORS**
- **100 Hp to 500 Hp**
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136	125	8x8	American-IR
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311	40	12x8	CPT-Penn-IR
364	20	12x7	Worthington-IR
368	100	12x10	IR-CPT
379	40	12x9	Worthington HB
386	115	12x12	Ingersoll ER-1
426	100	12x11	Ingersoll ES-1
503	60	14x10	IR-Sullivan
528	100	14x12	CPT-IR
622	100	14½x13	American AF-1
740	40	17x10	CPT-IR
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1—900 HP Springfield sectional header boiler, 400# W. P., 1926, A.S.M.E., Oil Burner equipment, deaerating heater, feed pumps. New Mexico.
2—824 HP Sterling Boilers, 1930, active certificate for 300# W. P. chain grate stokers, ELESCO superheaters, all auxiliaries, Austin, Minn.
2—750 HP, B. and W. Sterling type boilers, 225# W. P., 1925, A.S.M.E., oil firing equipment, all auxiliaries, New Mexico.
2—600 HP, B. and W. longitudinal drum, sectional header boilers, 1922, A.S.M.E. 200# W. P. Peabody oil burners, steel headers, New Jersey.
2—500 HP, B. and W. Boilers, 1916, retubed 1925, 209# W. P. Lawrence, Mass.
1—490# Walsh-Widener Cross Drum, Sectional Headers, 4" tubes, 1927, 450# W. P. all auxiliaries. West Point, Virginia.
1—400 HP Keeler C. P. Boiler, 1942, 160# W. P. new tubes and refractory, TODD mechanical oil burner and pump set. Overhauled, dismantled. Ready to ship. N. Y.

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2—400 HP, B. and W. sectional header boilers, 200# W.P., steel headers, A.S.M.E., 1921, South Bend, Indiana.
1—310 HP Keeler C. P. Boiler, 160# W. P. 1942, pressure parts ship in one piece. Lake City, Florida.
1—300 HP Keeler C. P. Boiler, 160# W. P., 1942, all auxiliaries. Milton, Pa.
2—250 HP Erie City, 3 Drum, Low Head Boilers, 1946, 200# W. P. Brick Set, fully automatic PEABODY BURNERS and auxiliaries. West Hanover, Mass.

PACKAGE BOILERS

1—500 HP CLEAVER-BROOKS, 150# W. P., 1947, No. 6 oil, pump set, New Jersey.
1—400 HP CLEAVER-BROOKS, 150# W. P., 1949, fully automatic, No. 6 oil. N. J.
2—350 HP Preferred Utilities Steam Generators, 200# W.P., 1948, fully automatic, No. 6 oil, Washington, D. C.
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1—938 KVA West. 3/60/480 V. 3600 RPM Terry EXTRACTION turbine nozzled 250 psig 500° TT 10,000# extr. 50 psig. Surf. Cond.
1—375 KVA G.E. 3/60/480 V. 3600 RPM, NON-CONDENSING nozzled for 150 psig, 5-10 psig back pressure.

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2—502 HP Heine water leg type 200# WP 480° TT Coxe chain grate stokers. New 1929.

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1—2000 HP Fairbanks Morse 6900 V. 60 cy.
1—1600 HP Fair. Morse 2300/4150 V. 60 cy.
1— 275 HP Ing. Rand. 240 V. 60 cy. (Gas)
1— 250 HP Buckeye 240 V. 60 cy.

MOTOR GENERATOR SETS—60 CY.

QU.	KW	MFR.	V.—DC	A.C.	RPM
1	3000	G.E.	250	13200	514
1	1500	G.E.	600	4150	600
2	1000	West.	660	4150	900
1	200	West.	275	2200	900
2	150	G.E.	250	2300	1200
1	75	Ridgway	125	220	1200

SYNCHRONOUS MOTORS

QU.	HP	MFR.	VOLTAGE	RPM
2	2000	West.	13200	1200
1	900	A.C.	2200	180
2	700	West.	2300	200
1	600	G.E.	2300	240
1	300	G.E.	2300	600
1	300	West.	2300	900
1	200	G.E.	2300	900

FREQUENCY CHANGERS

QU.	KVA	MFR.	CYCLES	RPM
1	12500	G.E.	25/60	300
1	3750	G.E.	25/60	300
1	3125	G.E.	25/60	300
1	2500	G.E.	25/62½	750
1	1875	A.C.	60/25	300
1	500	G.E.	25/62½	750

OIL CIRCUIT BREAKERS—Outdoor

4— 800 A. 132 KV West. G-222A-2500-MVA
1— 400 A. 73 KV Condit FO-40-250 MVA
2— 400 A. 37 KV G.E. FHKO-136-350 MVA
4— 600 A. 15 KV G.E. FHKO-139-750 MVA
1—1200 A. 15 KV G.E. FKO-139-350 MVA
7— 600 A. 15 KV G.E. FK-115-28-350 MVA I/D

TRANSFORMERS

4—	2500 KVA Mel.	6900—13800
4—	500 KVA West.	69000—6900
3—	400 KVA G.E.	66000/33000—2300/4160
3—	1250 KVA A.C.	44000/11500—460
3—	150 KVA Mel.	44000—2400/7200
3—	75 KVA West.	44000—7200/12470 Y—
4—	5000 KVA G.E.	40935/70900 Y—14500
3—	3333 KVA G.E.	33000/11000—2400/7200
4—	333 KVA G.E.	33000—7200/12470 Y
3—	200 KVA A.C.	33000—2400/7200/12470
3—	100 KVA West.	33000—240/480 NEW
3—	75 KVA Wag.	33000—7200/12470 Y
3—	1250 KVA G.E.	26400/13200—2400
4—	1500 KVA A.C.	25400/44000—6900/13800
4—	450 KVA A.C.	25410/41000—13280/23000
3—	1000 KVA Mel.	22000—2300
3—	100 KVA G.E.	22000—7200/12470 Y
1—	3000 KVA Stand	19050/33000—4160, 3 ph
1—	5000, KVA Pitts.	19050/33000—4160, 3 ph.
1—	600 KVA Stand.	13200—4600, 3 ph.
1—	450 KVA Penn.	13200—2300, 3 ph.
3—	200 KVA G.E.	13800—2300
3—	250 KVA Pitts.	7200—220/440
3—	100 KVA G.E.	7200—240/480
3—	150 KVO Wag.	6900—2300
3—	37½ KVA G.E.	6900—230/460
4—	150 KVA G.E.	4800/2400—240/120
3—	333 KVA G.E.	2300—230/460
3—	250 KVA G.E.	2300/4000 Y—115/230
3—	200 KVA West.	2400—240/480
3—	150 KVA West.	2400—230/115
1—	100 KVA G.E.	2300—575, 3 ph.
3—	75 KVA A.C.	2400—240/480
6—	50 KVA West.	2400—114/228 Dry Type

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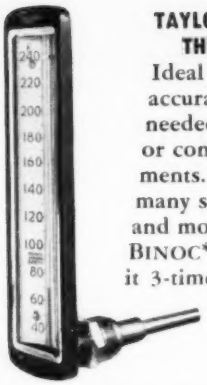

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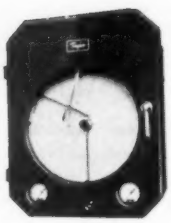
Ideal wherever you need a record of pressure, temperature or a combination of both. For example, accurately records steam and feed water temperatures and pressures, or oil, air and flue gas temperature.



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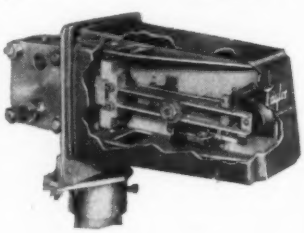

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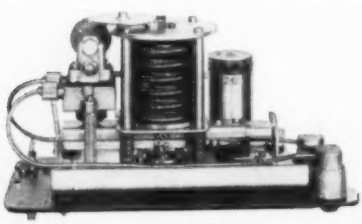

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- Can be bolted directly to the building structure or suspended by either single or double rods

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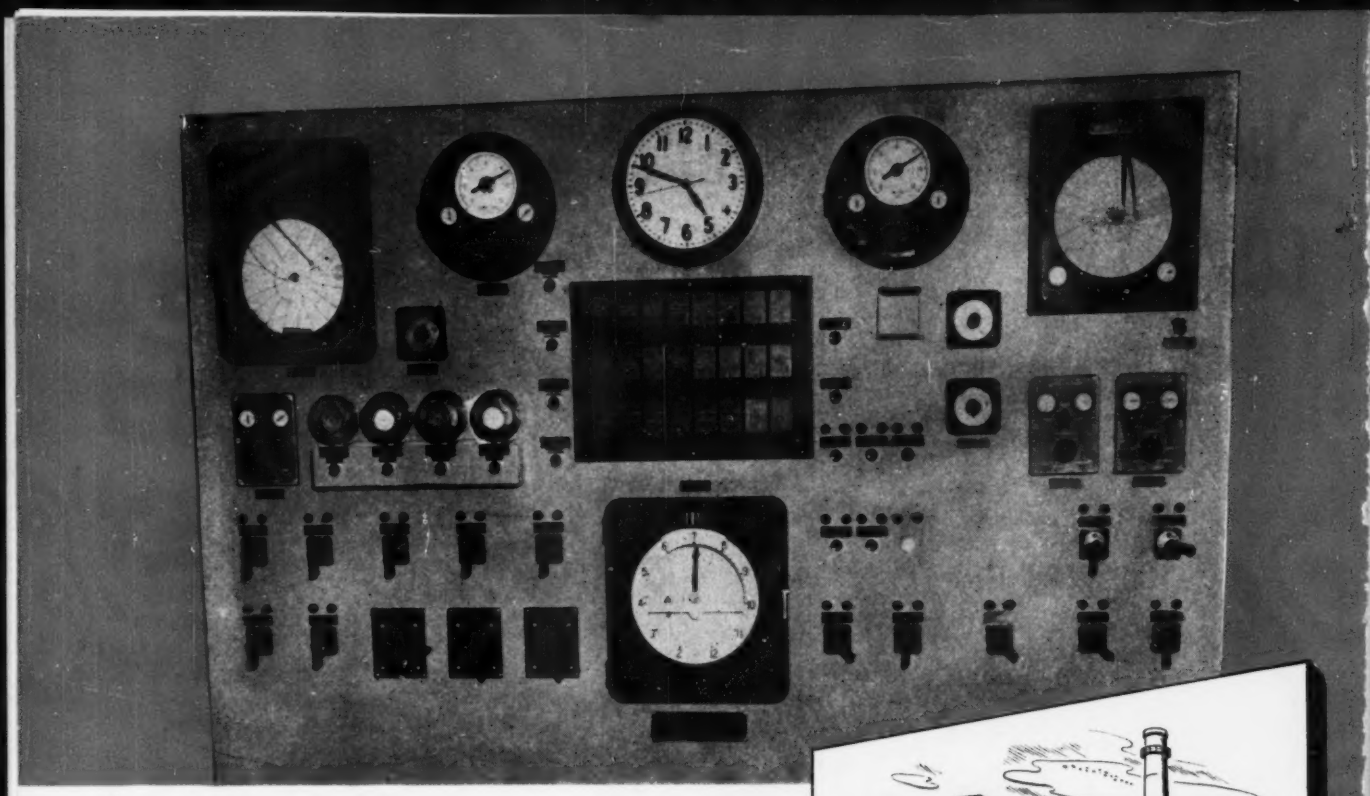

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